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Contents for March, 1939

THE PROFESSIONAL SPIRIT IN ENGINEERING . . . . . *Vannevar Bush* 195
CORROSION IN PARTIALLY DRY STEAM-GENERATING TUBES *F. G. Straub and E. E. Nelson* 199
ENGINEERING DEVELOPMENTS IN UNITED STATES MERCHANT MARINE . *J. E. Schmeltzer* 203
PRESENT-DAY POPULAR ECONOMIC THOUGHT . . . . . *G. W. Starr* 209
PERSONAL REFLECTIONS ON FORTY YEARS OF DIESEL-ENGINE DEVELOPMENT . *A. J. Büchi* 213
LATEST DEVELOPMENTS OF THE BENSON BOILER—I . . . . . *Francis Hodgkinson* 217
ENGINEERING LIBRARY AIDS ENGINEERS OF THE WORLD 222
A.S.M.E. HONORS AND AWARDS—V: SPIRIT OF ST. LOUIS MEDAL 224
TECHNOLOGY AND PRICE-MAKING . . . . . *R. E. Freeman* 226

EDITORIAL 193
BRIEFING THE RECORD 227
LETTERS AND COMMENT 239
REVIEWS OF BOOKS 247
A.S.M.E. BOILER CODE 250
A.S.M.E. NEWS 252

INDEX TO ADVERTISERS 40

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Gerald Young

Centerless Grinding

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MECHANICAL ENGINEERING

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1939

GEORGE A. STETSON, *Editor*

All He Can Get

ONE OF THE heretofore unrecorded sayings of that salty antagonist of the metric system, Fred Halsey, that delighted the few friends who heard it, was occasioned by a remark at the lunch table about the Soviet system of paying a man in accordance with his needs. "Hell," snorted the old man, "a man needs all he can get!" Thus the originator of the premium plan epitomized the American system of wage payment—all a man can get.

It is to be expected that the few individualists who have survived Mr. Halsey will continue to hope that they may never find their own salaries determined by formula but by personal negotiation with their employers, even though they may welcome formulas by which to set the wages of their employees, just as he devised a scheme for remunerating, with some recognition for superior effort, the workers in railroad shops. For except in the case of those who, individually, lack skill or opportunity, or who are so placed competitively that they can hope for no advantage except that gained for them by group action, men generally are likely to feel that wages are standardized at minimum levels and that they will find themselves caught in the coils of a system once standards are set.

Many employers have classified jobs and rates of pay, as, for example, government bodies, the civil service, and many universities. Barring accidents, a man in such organizations can plot his promotions and corresponding salary rates up to the time of his retirement. As engineering becomes more highly routinized, engineering positions and salary schedules lend themselves to such standardization, and probably a majority of workers, in the lower professional strata at least, look upon this as desirable. But there is one class, that of consulting engineers, where incomes defy any such standardization, although fees may be subject to informal grading. It is this group that, according to a recent study of the National Bureau of Economic Research, had higher incomes in 1929 than such professional groups as physicians, surgeons, dentists, certified public accountants, and lawyers. However, the depression served consulting engineers badly, for, from incomes approximately one third higher than that of the next highest in 1929, the drop in three years was to the lowest average. The drop is explained by the report as follows:

"The precipitous fall in the incomes of consulting engineers relative to those received in the other professions is not surprising. To a far greater extent than in the other professions the demand for the services of engineers comes from industries notoriously subject to violent cyclical fluctuations in activity—the construction and heavy industries in general. And consulting engineers are in an even more vulnerable cyclical position than engineers as a whole, since their services are required in larger part in connection with the initiation of new projects or the expansion of existing enterprises.

"The demand for the services of the other professions is much broader and is not concentrated in any one group of industries or final consumers. The broad pattern of change in their average net income resembles closely that in the average income from employment of all gainfully occupied persons."

At least one newspaper headline noting the report carried the implication that engineers, without qualification as to type or the year, have incomes in excess of those of other professions. Such announcements are misleading. In the first place, the vulnerability of these incomes to the fluctuating fortunes of industry must be considered, and in the second place, it must be remembered that consulting engineers represent only a small percentage of the total number of engineers. And there are other engineers in the higher salary groups whose fortunes may follow the pattern of consulting engineers.

Your thoroughgoing classifier will find a niche for every man from office boy to consulting engineer and bracket them all in groups with what he thinks are fair and appropriate wages. This is undoubtedly justice and protection for men in the lower brackets, but it is of doubtful service to men in the higher positions. Even though a man may never reach the top income set for his group he has a natural feeling of resentment that an upper limit has been placed for him and the danger always exists that a scale made for one class, such as civil-service employees, for example, may be looked upon by employers of other classes as a standard they may justly follow. Most men in the upper brackets, at least, will agree with Mr. Halsey that a man needs all he can get and he will make it his own business to see that he gets it.

A Roster of A.S.M.E. Committees

WITH the February issue of the Transactions of The American Society of Mechanical Engineers there was distributed to every member of the Society a supplement devoted to that part of the Society Records which lists the officers and committeemen for the administrative year 1938-1939. The purpose of this supplement is two-

fold. It places in the hands of every member an authorized list of persons who conduct the Society's affairs and, when bound into the complete Transactions for 1939, it becomes a permanent and historical record for future reference.

In so far as any unadorned compilation of names and committees can be so, this list is impressive. Merely by thumbing through the forty-odd pages the average member can obtain some notion of the extent and variety of the Society's official activities and of the great number of men who serve it voluntarily and thus make their personal contributions to the advancement of mechanical engineering. The great sources of strength and influence the Society possesses are seldom realized until some such evidence as this is made available. He would be a coldly matter-of-fact person indeed who could survey the evidence of active service to the engineering profession displayed by these pages and not experience a feeling of pride that he was taking part, even if only in a passive rôle, in the work of a Society that can marshal such an army of men and committees.

Such activities as are represented in the committees of the A.S.M.E. are made possible and effective because of the fact that they are conducted under the auspices of a society whose membership is representative of the mechanical engineering profession. The Society's name and prestige give authority to the work of its committees, but without the services these committees and their members perform the Society's name and prestige would count for little. Yet these reciprocal benefits themselves are made possible only by the loyal support of thousands of members, any one of whom may be called upon to take active part in the Society's committee work.

It was one of the ambitions of the late Calvin W. Rice that every member would have some source of reference to the personnel of every committee of the Society. The Society Records list distributed in February is the result of that ambition. Every member should file it, for it is a directory through which he can make direct approach to any Society activity that may engage his interest. Unfortunately, the Society has been unable this year to issue its Membership List, for the most useful arrangement would be to combine the two as was done in 1937 when the last roster of Society members was published. Until the time comes when an up-to-date Membership List can be issued, it is suggested that members paste the roster of committee personnel for 1939 in the back of the 1937 Membership List.

A National Resource

RESEARCH has always been the handmaiden of engineering progress, the friend of the inventor, the discoverer of new industries. Watt had his workshop—undoubtedly today we would call it a laboratory—now fortunately preserved intact through the zeal of H. W. Dickinson and reassembled in the Science Museum at South Kensington just as it was found at the time of the great man's death. Watt's genius and the achievements of his long useful life owed much to the spirit of research.

The success of the Watt steam engine depended on more than the brilliant flash of inspired inventiveness that conceived the separate condenser, as has been pointed out many times. Without the business sense and administrative skill of Boulton, without the improved boring mill of Wilkinson and the production techniques of Murdock, credit for a great invention might have gone to another man. Watt's debt to research, through his own work and that of such scientists as Black and Priestly, for example, is just another of those evidences of the many-sided partnership that makes successful progress in engineering.

Today the elements of this partnership are as important as ever, and, with the advance of science, the place of research becomes of increasing importance. Research has come out of the obscure shop, is shorn of its mystery, and has lost the reputation for impractical puttering that it once had with the public at large. It has become the great resource of industry, the means of advancing human knowledge on a thousand fronts, and of primary concern to governments. It has become the means by which authoritarian governments strive for world mastery and national self-sufficiency, and although under such control it loses some of the larger freedom necessary for maximum benefit to mankind and may be directed toward questionable objectives, it is nonetheless a powerful force that no nation can afford to neglect. There is, therefore, tremendous significance in our own government's recognition of this powerful aid to progress in a recent publication of a report by the National Resources Committee appropriately entitled "Research—a National Resource."

It will be recalled that several years ago a committee headed by Karl T. Compton, of M.I.T., presented a program of research activity as one means of combating the problems of the depression and unemployment. It was not put into effect. No one knows what might have come of it had it been adopted. It proposed to utilize research ability of men who were victims of the depression in the solution of problems that might have become the bases of new industries or the discovery of ways in which the wealth of the world could have been increased.

It is said that the federal government spent on research approximately $120,000,000 during the fiscal year ending June 30, 1937. This, however, "represented only about 2 per cent of the total budget, in contrast to industrial corporations which spent about 4 per cent of their budgets on research and universities which spent as high as 25 per cent of their annual budgets."

Research is a long-time investment. Money spent on it today will not reach many of the millions unemployed because only a relatively small number of persons are competent to engage in research. But those precious few who possess that magic skill might, perhaps, hasten the day of recovery and reemployment, and arm the nation against severe repetitions of economic disaster. It is encouraging to note that attention is being given to research, a national resource.

The PROFESSIONAL SPIRIT *in* ENGINEERING

By VANNEVAR BUSH

PRESIDENT, CARNEGIE INSTITUTION OF WASHINGTON

I AM HONORED in a very real sense by being asked to join in the deliberations of the distinguished group of engineers which is gathered here in Washington under the auspices of the American Engineering Council.

Three years ago, at Milwaukee, I attempted an analysis of the organization of the engineering profession.[1] Tonight I wish to develop that theme somewhat and I intend to trace briefly the relationship of engineering to the other professions, professional traditions which engineers inherit, and the outlook for the engineering profession in view of its unique relationship to society. I plan to review the history of professions very sketchily; but through this history runs a thread to which I wish especially to direct your attention.

VANNEVAR BUSH

We can start far back, but not tarry long in our review. In every primitive tribe there was some sort of medicine man. He was a man apart, the adviser of the clan rather than its titular leader. He spoke, in his field, with authority, and this --sted upon a special knowledge which he was supposed to possess. The medicine man was the progenitor of the professional man of today.

His closest modern counterpart is the scientist. The scientist and the medicine man have much in common. Tribal regalias and feathers have undergone metamorphosis and reappear in cabalistic titles and letters surrounding names. The queer jargon of the cult has changed in nature but preserved its hypnotic effect. Solemn pronouncements about the unknowable still catch the ear of the multitude. The claim to a favored position in society is still based on the occasional ability to "unscrew the inscrutable."

In fact, one difficulty that faces the scientist is that he may be mistaken for a medicine man; able at will to produce rabbits from hats, instead of the careful, hard-working, human individual he really is.

The descent of the engineer from the medicine man has been highly involved; and it will clarify some obscure relationships if we trace part of it; for there is a central thread which runs through the tale.

The medicine man, and the member of the pagan priesthood which succeeded him, was characterized by numerous attributes. He had a strict code of conduct. He trained neophytes, subjected them to a long period of apprenticeship, initiated them into the mysteries, and inculcated in them pride in the cult and rigid discipline in its formulas. He severely restricted his numbers by intellectual hurdles to be surmounted. He spoke a special language. He sat as adviser in councils of the mighty. But, more essential than all of these, he ministered to the people.

This was the first professional group, and all others have derived from it. Not every attribute has been maintained as new professions have emerged; but to a surprising extent their counterparts can still be found. In every one of the professional groups, however, will be found the initial central theme intact—they minister to the people. Otherwise they no longer endure as professional groups.

Ministry needs definition for our purposes. The alteration of word meanings with new usages is such that it is only too easy to be misunderstood. Ministry is not service, and we have so completely altered the essential significance of the latter word that it may have utterly different connotations to different hearers. Ministry carries with it the ideas of dignity and authority; it connotes no weakness, and offers no apology. The word has been carried into diplomatic usage; and in the derived form of administer, into law and business. There is no fog of subservience surrounding the concept. The physician who ministers to his client takes charge by right of superior specialized knowledge of a highly personal aspect of the affairs of the individual. The attorney assumes professional responsibility for guiding the legal acts of his client and speaks with the whole authority of the statutes as a background. It is in this higher sense that we trace the thread of ministry to the people.

This is the fuel which has kept alight through many ages the professional spirit. Every time that the fuel has become exhausted, the light has gone out. It has not mattered how much was retained of trappings and mysticism, nor what the profundity of utterances; there has been no true profession that has not with dignity and authority advised and counseled the people, that has not guarded the commonweal. For a true profession exists only as the people allow it to maintain its pre-

[1] "The Engineer and His Relation to Government," by Vannevar Bush, *Electrical Engineering*, August, 1937, pp. 928–936.

An address before the American Engineering Council, Washington, D. C., Jan. 13, 1939.

rogatives by reason of confidence in its integrity and belief in its general beneficence.

The monastic orders, under divers religions, springing up as outgrowths of the simpler systems of priestcraft, have exemplified the theme in two ways. Some have preserved, adorned, and extended the knowledge of their time and place. These have their modern counterparts in the scientific and learned groups, the custodians of our culture, and the source from which flows new knowledge for the use of man. Other orders carried to great heights the direct ministry to those in misfortune or distress; often at great self-sacrifice, as did the early Jesuits among the Indians of our West. Both forms have remained high in the esteem of the people and have endured. Occasional groups have lost the thread, and have, for example, become militant orders devoted to self-aggrandizement, and these have disappeared.

Out of the early priesthood came also the teaching orders, whose ministry took the form of instruction of the young, and this aspect of professional activity is represented today by the great profession of teachers everywhere. This group has little indeed of the trappings of the medicine man, it has no single closely knit aggressive society representing it; its language is becoming complicated but is still fairly intelligible to the layman. Where it has maintained its ideals it is honored and respected. Great teachers do not find riches heaped upon them, they do not become affluent. Great teachers have no interest in riches. In the great teacher the parental instinct, which is so often at the basis of senseless extremes of individual striving for wealth, becomes sublimated into a broad love of youth which calls for neither wealth nor power for its enjoyment and satisfaction.

MEDICINE'S HERITAGE OF IDEALISM

A very early offshoot was the profession of medicine, for ministry to the ill was a primitive need. It has had a long and distinguished history. Utilizing the fruits of science it is today in full tide of accomplishment for the benefit of mankind. It has had vast power and influence. Yet, today, in this country it is at a turn of the road, and its most thoughtful members are giving earnest consideration to its future. There is serious danger that its light may fail, and its heritage of idealism may be lost.

The profession of medicine, by reason of its very nature, has preserved many of the attributes of the ancient forms. It selects its neophytes by rigorous intellectual elimination, trains them over many years, and seeks to endow them with the philosophy of their profession. It severely restricts its own numbers, perhaps too severely in view of the task before it. It preserves itself apart, by special language, and has a unique code of conduct. It has sat in the councils of government and advised. By the will of the people it has been given special privileges and prerogatives for use in pursuit of its objectives. It is highly organized.

Through long ages it has held well to its ideal of simple ministry to the people and has disciplined under its codes those who would use its special privileges for other ends. It had guarded the people against their own folly, and has been properly militant in maintenance of its sphere of the public weal. Its individual members are in general respected in their own communities to an extraordinary degree.

Yet, in these days when all institutions are undergoing scrutiny, when our population in fear and distress is prone to be critical, there is evidence about us that the profession, as a profession, does not command that full support of the people of the country without which it cannot continue on the path. Yet as one looks about in the medical profession signs are seen of a resurgence of idealism, a reemphasis on the simple mission of healing, and a recognition of the central theme of ministry to the people. This, I am convinced, is the true motive of the great majority of the members of this grand profession. Yet there is much suspicion in the public mind that aggrandizement, utilization of power for the professional advancement of the membership, the guild spirit in its cruder form, are rampant. I second the thought of many eminent members of the profession itself that unless this suspicion is allayed by a revival of simple ideals, the profession will suffer, and the people will suffer enormously with it. It is well that engineers should be deeply interested in the outcome, for medicine is a very ancient profession from which we have much to learn.

PROFESSIONAL ASPECTS OF LAW

To treat the origins of the profession of law, its codes and countercurrents, would require a paper in itself. Here is a field in which the preservation of the true philosophy of a profession is intricate indeed. Endowed with special privilege under the law, it largely regulates its own conduct. Never quite successful in the recruiting, training, and indoctrination of its neophytes, its maintenance of adherence to a high code of conduct is rendered more difficult. Counseling with government, and by the nature of its mission, participating directly therein, it has great power for good or evil. It certainly strives, as an organized profession, for the public welfare; but its zeal in this regard is not always such as to cause it to disregard the special welfare of its own group, and the two, withal, are sometimes hard to disentangle. It ministers to those in legal distress with great effectiveness; but the distressed often appear in pairs. It is hardly judged as a whole by the public. Certain it is, however, that those of its membership, on the bench or at the bar, who have risen to the highest positions in their devotion to professional ideals, are respected and honored by the public. Certain it is also, that should this respect falter, we as a democracy would soon be in a sorry state.

IS ENGINEERING A PROFESSION?

But our principal concern tonight is the engineering profession, and we inquire, what is the engineering profession; is it a profession at all; and if it is, will it develop into the full stature to which the importance of its works entitles it to aspire?

It is relatively young. The military engineer appeared in the first steps of the mechanization of warfare when forts began to take shape. His counterpart in peaceful affairs was called a civil engineer. With the industrial revolution, and especially with the spread of mechanization from the factory into every walk of life, engineering became exceedingly diversified. Applying science in an economic manner to the needs of mankind is its broad field. Its disciplines are spread over all the sciences as they become thus applied, and embrace also portions of economics, law, and business practice which are integral parts of the process of application. It is somewhat loosely organized as professions go. To a minor extent only it limits its numbers; but the very strictness of its essential disciplines provides some selection of its neophytes. Until recently it has done very little in an organized fashion to inculcate in its younger members the philosophy of the profession, leaving this largely to those of its individuals who are also members of the teaching profession. That branch which represents the consultant, and others to a degree, has drawn codes; but there is no body of codified principles which is accepted and applied by the profession as a whole. It has no highly distinct language or jargon, for it must continuously work with laymen.

These are, however, incidentals. The important point is this: Does it have a central theme of ministering to the people? Most certainly it serves the public in myriad ways,

but are its individual members activated primarily by the professional spirit of dignified and authoritative counsel and guidance?

INDICATIONS OF A PROFESSIONAL QUALITY IN BUSINESSMEN

In order properly to inquire into this weighty question, we need to digress a moment to consider another large group of the population, the modern men of business who have derived from the ancient traders and merchants. The merchant class has not usually been a professional grouping in the true sense; and engineering, which has derived its philosophy from this source as well as from science, naturally partakes of the heritage of both groups. Business has served the public, of course, but its main theme has been the profit motive, a salutary objective when restricted by law to the use of ethical procedures in its pursuit, but not a professional objective.

One of the most encouraging signs of the times is the gradual emergence in our day of truly professional men of business. Scattered, not organized, with no sign of professional trappings, they are nonetheless possessed of a high mission, which needs only formulation and recognition in order that they may constitute a new and strong profession. This is occurring for one reason because of a gradual change in corporate form. The owner-manager was activated by the profit motive, and no amount of paternalism could wholly alter his position in the social scheme. Even with corporations, the ownership of which is widely scattered, the manager is ordinarily controlled by, and primarily responsible to, a few powerful owners, so that he in essence still represents the interest of the owners in his relations with the three bodies with which he deals—the government, the employees, and the consuming public. It is his difficult task to reap for the owners' benefit the fruits of his industrial operation, while maintaining at least tolerance on the part of the other bodies. But there are some corporations in which ownership is so diffused that the management becomes in effect a self-perpetuating entity, partaking therefore of the nature of a trusteeship, with equally weighed obligations and responsibilities to all four bodies—owners, employees, government, and consumers. Among such managing groups will be found individuals who have the professional philosophy in high degree, conducting their affairs for the just and equitable benefit of all four groups concerned, maintaining the health and progress of their institutions as potent agencies for ministration to the needs of the people. They find common ground with the trustees of great foundations, of hospitals, and all nonprofit organizations devoted to the public welfare. They find common ground also with many of those who make a career of the business of government. Their ranks are recruited by many in the ordinary walks of business who have seen a light and envisioned a function in life which is higher in its satisfaction than the struggle of any body against any other, namely, a struggle with all bodies to preserve an ideal. Out of this trend, as competition for industrial existence becomes tempered, should emerge a new profession with its own traditions and beliefs, which is capable of managing prosperity so that it will be conducive to the health of a nation; and there is grave question whether this objective can be attained in any other way. I wish there were a special order of knighthood in this country to honor and unite those who are now blazing the difficult path and developing the novel philosophy of this new profession.

ENGINEERING DERIVED JOINTLY FROM SCIENCE AND BUSINESS

Engineering, however, derived jointly from the quiet cloisters of science and from the turmoil and strife of aggressive business; and it is no wonder, therefore, that it should wabble a bit as it seeks to evolve its own professional philosophy.

Just as it is not reasonable to expect the young neophyte to grasp at once the idealism of his calling, so it is perhaps not reasonable to expect a profession which is so young and which has grown so fast to have found itself in this regard.

The period of initiation into any profession should extend into maturity. Only when members reached the full bloom of manhood did the ancient orders entrust the mysteries to their care. The young neophyte served his apprenticeship under constant tutelage and close guidance by mature minds, and this we still find in every profession. As apprentice, as employee, he is called upon to prove himself, before he enters into that relationship where his opinions are controlling in his special field; and some there are who never emerge from close control and the mere exercise of technical proficiency. In the engineering profession this emergence is usually circumscribed by the fact that most engineers operate as members of industrial organizations of one sort and another, and the fact that they serve their apprenticeship in this same sort of organization rather than to enter after professional recognition elsewhere, as is usually the case with medical or legal individuals who come to devote their entire efforts to the affairs of one organization. This, however, merely emphasizes the need for better supervision of the neophytes by the members of the engineering profession who have arrived. It is not enough to leave their training to the industrial organizations of which they are junior members. Inculcation of the principles of the profession can come only from those who have themselves attained to a full grasp of its proper function in society, who have arrived at a balanced judgment as to its responsibility to the several groupings of which society is composed, and who have a professional interest in the young men who are destined to succeed them in the profession. Every profession should have its secrets and its mysteries spread before the world that all may read, but truly grasped only by those who have lived the professional life; and these should be transmitted to the neophytes with due care, with reverence for their inherent worth, and in due time. Ritual and symbolism, secrecy and circumspection, were the ancient paraphernalia which insured a proper seriousness in youth in order that the impartation might be impressive. These have not wholly disappeared in the modern professions. Admission to the bar, the use of the title of doctor, and similar customs and usages have profound effect in producing a professional consciousness. The engineering profession is wholly without these aids, and its task of inducting its neophytes into the true professional atmosphere is thus rendered doubly difficult.

THE TASK OF THE ENGINEER IS PROFESSIONAL

But does it matter after all? Are the things that engineers do so vital that they must needs be approached in the professional spirit? Most certainly it matters. And most certainly the task is a professional one. The impact of science is making a new world, and the engineer is in the forefront of the remaking. He lights the way in a very literal sense. He brings peoples close together for better or worse, by facile communication and rapid transportation. He guards the food supply, and replaces the hopelessness of Malthus with an embarrassing plenty. He shortens the hours of labor, and fills the consequent leisure with distractions. He temporarily disrupts the techniques of whole industries, and thus alters the life habits of many people, in maintaining a continually rising standard of living. He bores through the earth and under the sea, and flies above the cloud. He builds great cities, and builds also the means whereby they may be destroyed. Certainly there was never a profession that more truly needed the professional spirit, if the welfare of man is to be preserved.

There is no lack of signs of a rising consciousness in this

regard. The profession is most positively vocal. There is a vigorous new organization, linking several large groups, devoting itself to the improvement of the education of the young engineer, and the instillation of high principles during his early career. Engineering literature is full of discussions of the duties and responsibilities of the profession, and out of this may crystallize some day a code, a set of principles of conduct, a guide drawn solely with the object of advancing the public weal, which will become accepted by engineers everywhere, whether in government employ, private practice, or industrial organization. Having, to some extent at least, consolidated their techniques, engineers are certainly giving thought and voice to their position in society, and to their responsibility for the use of the great works which they create.

A.E.C. FOCUS OF ENGINEERING PROFESSIONAL SPIRIT

The focus of this whole affair is the American Engineering Council. More than any other group it represents the engineering profession as a whole, in its relationships with government, other professions, and the public. Here, more than in any other organization, reside the external as contrasted with the internal relationships of the profession. It was founded by men who considered its functions in terms of a high idealism. It is now going through a strenuous period of self-examination. To this every individual can contribute only one set of thoughts to be merged with all of those which seethe, and interact, out of which will come in due time that consensus which will form the opinions, traditions, codes, consciousness which will mold the engineering profession. It will come unless the Council fails; for if it fails, and if its place is not taken by a more rugged successor, there will be no unitary engineering profession at all. In the spirit of adding my few thoughts to those of the eminent men who are directing the Council I have previously offered comments, and I now comment again, with the expectation that I will be disagreed with and answered, with the wish to add my mite to the consummation.

I find it a vigorous and rapidly evolving body. I consider it to be utterly inadequately supported by the profession as a whole, in comparison with the central bodies of sister professions, and with a serious problem as to how adequate support can be drawn for the great task that lies ahead of it. I find it partaking of the great American tendency toward overcomplication, and inclined to attempt things which seem to me personally to be off the main beat. I find to my great joy that it is gradually becoming known and recognized; and I trust this is just a beginning. I find it with that greatest of assets, a devoted, energetic, and high-minded executive secretary; guided by some of the best minds in the profession as its officers, who are giving valuable time to its cause; and I hence cannot fail to be optimistic as to its future.

A.E.C. FACES DIFFICULT AND IMPORTANT TASK

To me, however, there is just one point on which I wish to focus attention. I find it struggling with its own philosophy. I find, in fact, that it hesitates as it formulates its idealism; that it has not yet placed its foot unequivocally and irrevocably upon the path that leads to complete devotion to the public welfare. I find that it has not yet enunciated its belief that the great mission of the engineer lies in intelligent, aggressive, devoted ministration to the people. This I urge with all the emphasis I can command.

I do not seek to conjure away practical difficulties by ignoring them. I know full well what restricted budgets mean. The argument that the support of the membership can be obtained only if they can see a direct and personal benefit from their contributions has a familiar ring. I recognize that it is entirely proper for professional men to join in an insistence upon a reasonable and proper recognition of their services to society. Yet I say to you this: If there is no central organization which has as its creed the best service of the profession to the society of which it forms a part, then there will be in the end no engineering profession. Professional status rests in perpetuity, not on transient law, not on the cruder machinations of the ancient guilds, not on exclusive control of those having a specialized and necessary knowledge, but upon the respect and fundamental support of the people who are served; who only in the long run can insist upon the maintenance of prerogatives, and confer honor, recognition, and special privileges in society upon the members of a profession.

WILL ENGINEERS SUPPORT A.E.C. AND THE PROFESSIONAL IDEAL?

Will engineers support such a program? Will they contribute directly or through their specialized societies to the development of this ideal, and its exemplification in Council projects aimed at rendering real some aspect of the profession's contribution to public welfare? Will they make possible great forums for the crystallization of engineering opinion on public questions involving engineering, not to attain an impossible unanimity or produce high-sounding resolutions, but so that all aspects of controversial matters may be aired in order that people may know what engineers think? Will engineers go along heartily in developing a professional consciousness, a code of action, a philosophy which implements a desire to be a truly professional group, oriented primarily toward the advancement of the public health, safety, comfort, and progress? Will they accept as the central theme the engineers' ministration to society, without fear of any class, and without prejudice toward or away from any special social interests or causes?

If they will not, then there is no truly professional spirit to build upon. We may as well resign ourselves to a general absorption as controlled employees, and to the disappearance of our independence. We may as well conclude that we are merely one more group of the population, trained with a special skill, maintaining our economic status by a continuing struggle against the interests of other groups, forced in this direction and that by the conflict between the great forces of a civilized community, with no higher ideals than to serve as directed, and with no greater satisfaction than the securing of an adequate income as one member in the struggle for the profits of an industrial age.

But I know the minds of too many engineers to be thus pessimistic. I recognize the distinguished careers of a generation of men who have practiced in the profession to its credit and honor. Though the task be difficult, on account of the nature of many of our relationships to society, nevertheless traditions are being formed, the consciousness of the membership is becoming aroused, and I confidently expect the profession of engineering to develop in a manner of which we can be justifiably proud.

And to those in the ranks, who may not have yet seen the light, I would preach the doctrine, without pulling any punches, without mincing any words, that the path of professional attainment lies open before them, that it is a thorny path that is easily lost sight of among the rocks and rubbish, that it can be adhered to only by sacrifice and by support of those who lead the way, that it is a long path which leads down into the valley into which the sun does not shine, but that it leads at last to the heights. To the heights of true professional attainment, where honor and individual recognition by fellows is the real reward, and where the watchword is that old, old theme, which has never lost its power, and which may yet save a sorry world, simple ministration to the people.

CORROSION *in* PARTIALLY DRY STEAM-GENERATING TUBES[1]

By FREDERICK G. STRAUB and ELWOOD E. NELSON

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BOILER OPERATORS have noted the presence of partially dry areas in steam-generating tubes of boilers for many years. One area where this has occurred has been in the upper end of straight and bent generating tubes. The presence of the "dry areas" has been indicated by the so-called "water lines." Due to the fact that these have been in areas of relatively low heat transfer, small attention has been paid to them. In some instances attempts have been made[2] to eliminate these dry areas. In other cases the attack on the tube has been so slow that little attention has been paid to this difficulty. Recently, with the trend toward higher pressures and higher rates of heat transfer along with the more complicated boiler-water circulation, the presence of rapid corrosion in certain areas of the boiler in the absence of dissolved oxygen has again called attention to the effect of these dry areas. These areas have occurred in the upper generating tubes, in floor tubes, and in sloping floor screen tubes. In several instances severe corrosion has occurred in the dry areas of the tubes while the rest of the tubes are unaffected. In other cases the dry areas are evident but no corrosion has occurred.

In order to study the cause of the corrosion in certain cases and its absence in other cases a laboratory study has been made. The procedure of the laboratory work has been to generate steam in a tube under such conditions that a partially dry area exists. Solutions of known composition are tested in a steam-generating tube under these conditions and the effect on the tube studied.

DESCRIPTION OF TEST APPARATUS AND PROCEDURE

Fig. 1 shows a photograph of the test apparatus used. A steel tube $^{15}/_{16}$ in. ID × $1^{5}/_{16}$ in. OD and 13 in. long which has been machined inside is connected to a vertical condenser tube. The steel generating tube is heated electrically by means of resistance wire. The temperature of the outside top and bottom of the tube is obtained by means of constantan thermocouples peined into the tube at the center of the heated area. A thermocouple well is inserted from the end of the tube in order to measure the temperature of the solution inside the tube. All temperatures are recorded on a multiple-point, recording, potentiometer-type recorder.

The procedure followed in conducting the test has been to pour the solution (100 ml) to be tested in the longer tube (inverted), assemble the apparatus, and start heating. The heating tube is held horizontal until the desired temperature is obtained within the tube. Under this condition the temperature on the outside of the tube top and bottom are almost identical and range about 60 F higher than the inside temperature. This temperature is not the real skin temperature of the tube since some heat is transferred from the heating wire to the thermocouples. However, since the two temperatures are almost identical it indicates that the rate of heat transfer at the top and bottom of the tube is about the same and that steam is being generated all around the tube.

The heat input is maintained constant (about 21 amp, through 18 ft, No. 14 Chromel A wire) and the temperature of the solution in the tube is controlled by varying the heat release in the condensing column. This is accomplished by connecting the fan to a regulating potentiometer controlled by the thermocouple in the thermocouple well. When the temperature is too high the fan is turned on. The temperature is controlled within ±10 F.

Two procedures have been followed in order to remove oxygen from the tube. The first was to evacuate the tube prior to heating and the second was to vent the air through the valve at the top as the tube was heated. No difference in results was noted and the latter method has been used in all tests discussed.

After the tube has been at the desired temperature for about fifteen minutes the end away from the condenser is lifted by turning down the screws at the end. As this end is lifted the temperature at the outside top of the tube increases and varies according to the amount the tube is inclined. This is due to the fact that steam is trapped in this end of the tube, and, since the rate of heat transfer through the steam is less than through the water, the metal temperature increases. This indicates that a "dry area" has been produced within the tube.

The tests have in general been conducted for about twenty hours. At the end of the test the current is shut off and as the temperature within the tube reaches about 300 F the gases collected in the top of the condenser are released through the small valve, collected, and measured. This collection of gas was not done for the first few tests. The gas collected consists largely of hydrogen.

RESULTS OF TESTS

The first test was conducted with distilled water and the tube was not inclined. No dry area existed and the tube was found to be covered with a thin film of black iron oxide and there were no indications of corrosion. Table 1 gives the results of other tests conducted. These tests were all run with the tube inclined. In all these tests the so-called "water line" was in evidence at the end of the test. In test 533 distilled water was used and no corrosion was noticeable at the end of the test. Another test was then run (534) using the same tube but substituting a sample of boiler water. This boiler-water sample was obtained from a 600-lb-pressure boiler which had never experienced corrosion due to dry tubes. The A.S.M.E. ratio of this water was 3.5 and no phosphate was present. No corrosion was noticed at the end of this test. Fig. 2 shows a photograph of the inside of the tube which was split after being run

[1] The results reported are part of the investigation conducted under a cooperative agreement between the Utilities Research Commission, Inc., Chicago, Ill., and the Engineering Experiment Station, University of Illinois, Urbana, Ill., and are released by permission of both parties.

[2] "Circulation in Water Tube Boilers," by R. M. Hanson, McGraw Prize Paper, *Edison Electric Institute Bulletin*, vol. 4, September, 1936, pp. 385–394.

Contributed jointly by the Power Division and the Joint Research Committee on Boiler Feedwater Studies for presentation at the National Spring Meeting, New Orleans, La., February 23–25, 1939, of The American Society of Mechanical Engineers.

in tests 533 and 534. The water line shows clearly in the top of the tube and there is no evidence of corrosion in the tube in the dry area. The boiler water was then concentrated and run in a new tube, test 537. No corrosion occurred in this tube, as shown in Fig. 3.

A synthetic solution was then prepared containing pure sodium hydroxide in distilled water and tested in a new tube, test 535. This tube showed heavy corrosion at the end of the test as shown in Fig. 4. The upper dry portion of the tube had a heavy, mixed dull-black and shiny iron oxide forming on it. The lower portion showed freedom from attack.

In test 532 a synthetic solution was made containing pure sodium hydroxide. This test produced corrosion.

In test 538 a synthetic solution was made containing pure sodium hydroxide and phosphate. This test also produced corrosion as shown in Fig. 5 and indicated that the phosphate would not prevent corrosion in the presence of sodium hydroxide. A test was then conducted (539) using trisodium phosphate alone in distilled water (200 ppm PO_4). No corrosion was detected at the end of this test and the amount of gas generated was low (25 ml).

A sample of boiler water from a boiler operating at 1250 psi pressure which was experiencing corrosion in partially dry tubes was then tested (540). This boiler water was concentrated in a stainless-steel retort at atmospheric pressure prior to being used in this test. At the end of the test 196 ml of gas was collected and the tube showed evidence of corrosion.

In test 546 a solution of sodium hydroxide in distilled water produced 518 ml of gas and caused heavy corrosion in the tube. The addition of 35 ppm of SiO_2 reduced the gas evolved (test 541) to 408 ml. When sodium sulphate was added to the sodium-hydroxide-silica solution so that the sodium sulphate was present in an amount equal to 0.6 times the total alkalinity (test 551), the gas evolved was reduced to 220 ml. When the sodium sulphate was increased still more (sodium sulphate = 2.2 × alkalinity test 550) the gas evolved was only 50 ml and

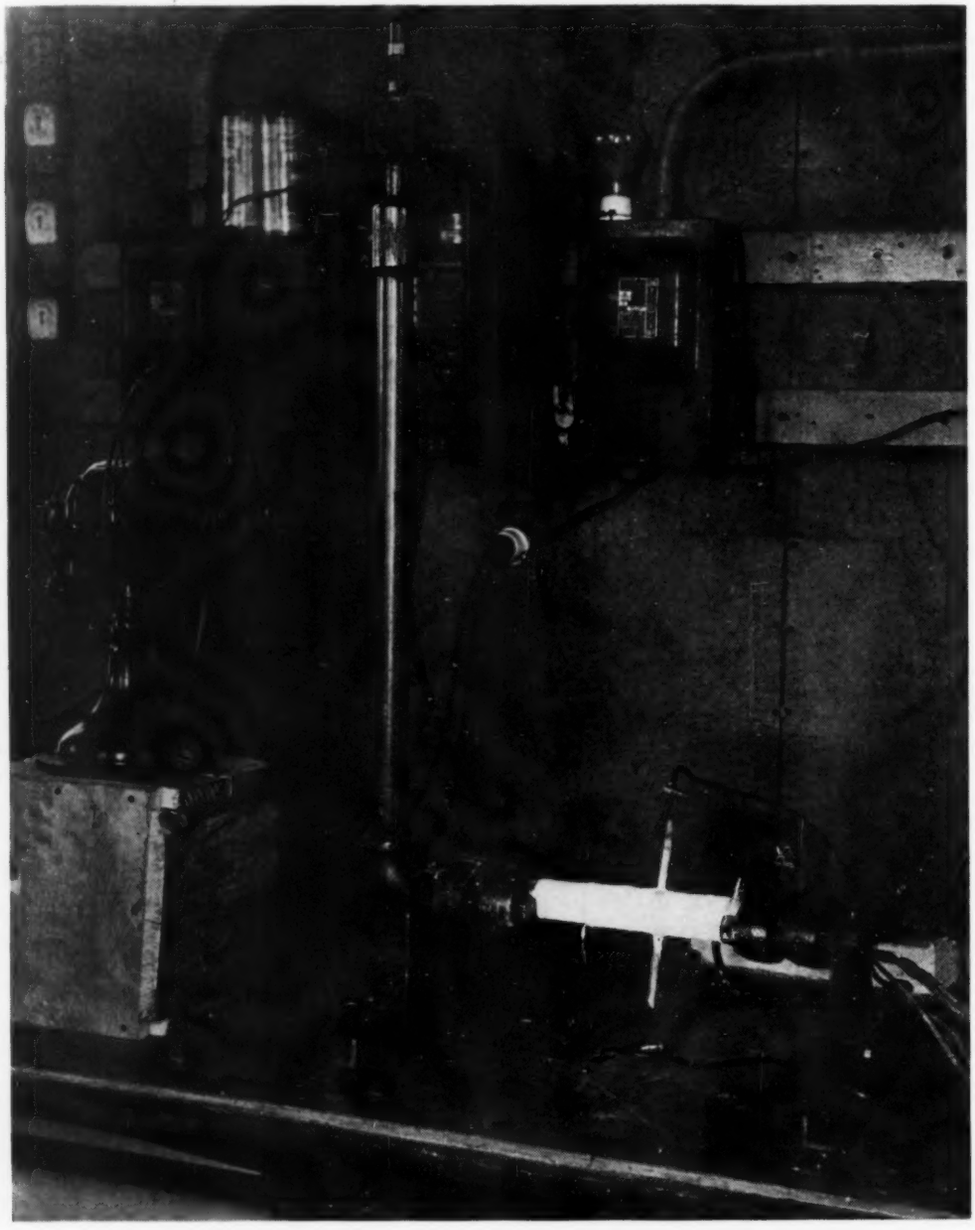

FIG. 1 TEST APPARATUS USED

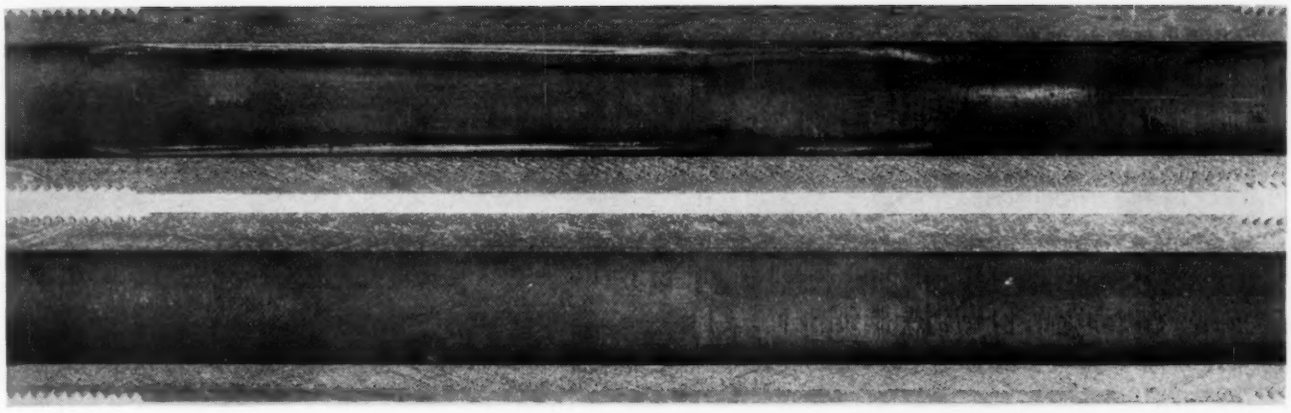

FIG. 2 TUBE AFTER BEING RUN IN TESTS 533 AND 534—SHOWING NO CORROSION

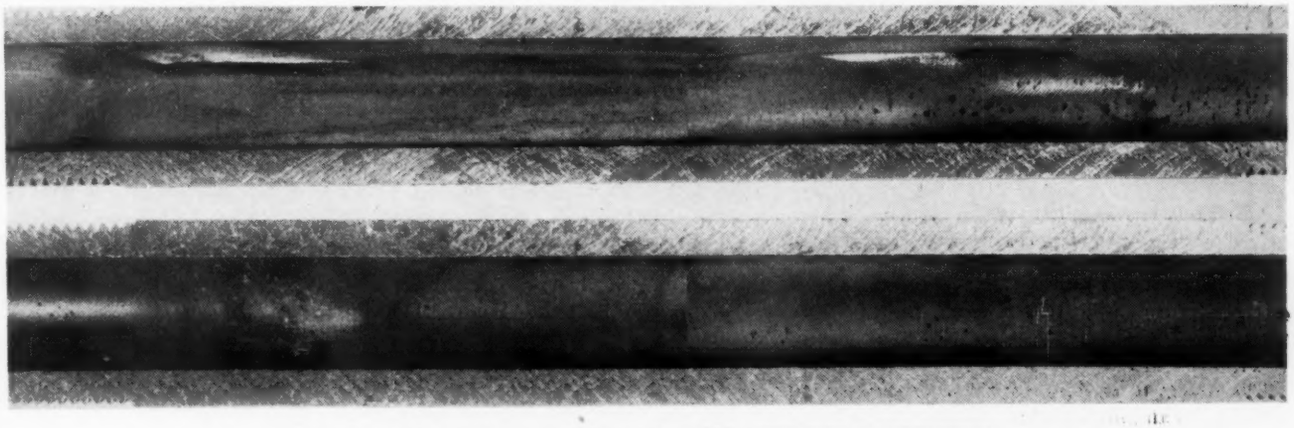

FIG. 3 TUBE AFTER BEING RUN IN TEST 537—SHOWING NO CORROSION

FIG. 4 TUBE AFTER BEING RUN IN TEST 535—SHOWING HEAVY CORROSION AT TOP OF TUBE

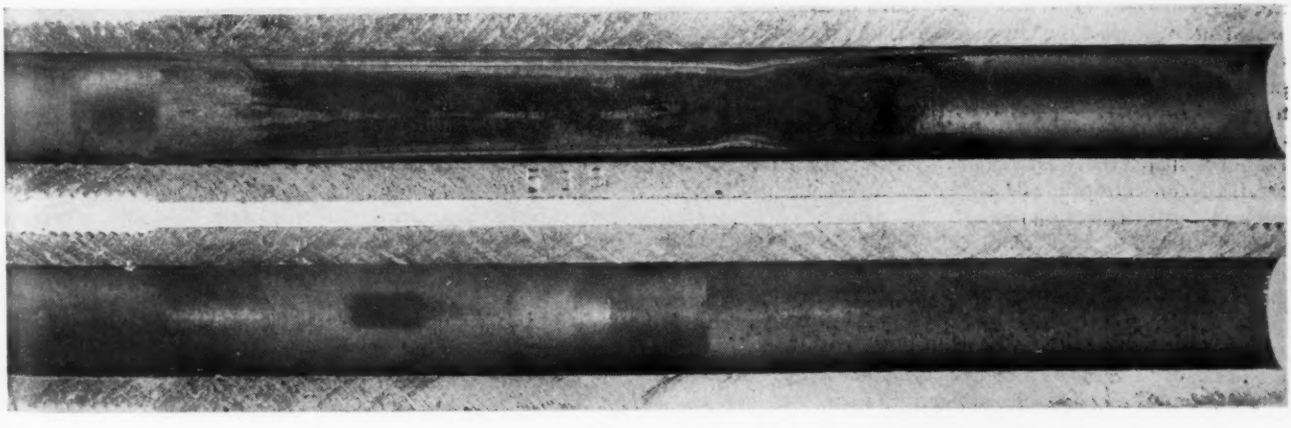

FIG. 5 TUBE AFTER BEING RUN IN TEST 538—SHOWING HEAVY CORROSION AT TOP OF TUBE

TABLE 1 RESULTS OF CORROSION TESTS CONDUCTED ON PARTIALLY DRY STEAM-GENERATING TUBES

Test no.	Duration of test, hr	Temperature			Solution tested							Gas generated, ml	Results of test
		Inside	Bottom outside	Top outside	NaOH	Total alk	$\frac{Na_2SO_4}{alk}$	$\frac{NaCl}{alk}$	SiO_2	R_2O_3	PO_4		
533	21	600	680	730	0	0	0	0	0	0	0	...	No corrosion
534[1]	22	600	690	740	180	343	3.5	0.7	14	3	0	...	No corrosion
537[2]	21	600	680	760	500	810	3.5	0.7	33	7	0	...	No corrosion
535	45	600	655	715	650	880	0	0	0	0	0	...	Corroded
532	21	600	690	750	1000	1400	0	0	0	0	0	...	Corroded
538	44	600	655	705	530	1020	0	0	0	0	200	...	Corroded
539	23	600	660	710	0	330	0	0	0	0	200	25	No corrosion
540[3]	22	600	650	725	320	600	0.8	0.5	17	24	0	196	Corroded
546	20	600	660	720	575	800	0	0	0	0	0	518	Corroded
541	20	600	690	755	575	810	0	0	35	0	0	408	Corroded
551	40	600	650	695	570	825	0.6	0	35	0	0	220	Corroded
550	47	600	640	700	570	825	2.2	0	35	0	0	50	Slight corrosion
549	20	600	650	700	570	800	4.5	0	35	0	0	10	No corrosion
542	20	600	660	710	570	1100	3.3	0.7	35	0	0	18	No corrosion
543	20	600	660	710	550	1100	3.3	0.7	0	0	0	105	Corroded
544	75	600	660	710	530	750	4.8	0.7	35	0	0	15	No corrosion
545	20	600	660	730	530	750	4.8	0.7	35	20	0	10	No corrosion
573	18	600	650	890	0	0	0	0	0	0	0	50	Corroded
575	26	600	640	830	590	815	3.0	1.0	0	0	0	375	Corroded
576	23	600	660	830	590	850	3.0	1.0	35	0	0	120	Corroded
577	22	600	640	830	530	768	3.1	1.0	35	0	60	220	Corroded

[1] Same tube used as in test 533.
[2] Same solution as in test 534 concentrated prior to test. This is a boiler-water sample.
[3] Boiler-water sample.

only a slight amount of corrosion could be detected. In test 549 the A.S.M.E. ratio was increased to 4.5 and the gas evolved was reduced to 10 ml with no corrosion present.

The A.S.M.E. ratio in test 542 was held at 3.3 and NaCl was added in an amount equal to 0.7 times the alkalinity. The gas evolved was only 18 ml and no corrosion could be detected. In test 543 the solution was the same as used in 542 with the silica left out. With this change 105 ml of gas was evolved and the tube was corroded.

In test 545 the solution used contained sulphates, chlorides, hydroxide, silica, and aluminates and the gas evolution was only 10 ml with no corrosion shown on the tube.

In order to study the effect of higher metal temperatures on the tube corrosion, tests 573–575, 576, and 577 were conducted. In test 573, distilled water was used with a maximum temperature of 890 F. This test gave 50 ml of gas and there was definite corrosion in the dry area. The other tests run at the higher temperature showed that the addition of sulphate, chloride, silica, or phosphate did not prevent the corrosion.

DISCUSSION OF RESULTS

The results which have been obtained in these tests appear to indicate that there is a relationship between the corrosion in the dry areas, the metal temperature, and the composition of the water. At the same time there is a relationship between the gas generated (H_2) and the amount of corrosion. This would indicate that the chemicals in the boiler water concentrate on the dry portion of the tube. The increased wall temperature would indicate the possibility of a small area of superheat, and in this area the concentration of the chemicals might reach high values. No corrosion is detected in the portion of the tube where no dry area exists. This would indicate that a localized concentration and slight increase in temperature is essential for the corrosion to start. Since the two boiler waters tested produced such different results, it is evident that the salts in solution might have a marked effect on the corrosion in the dry area.

The corrosion in the dry area is undoubtedly produced by the action of the sodium hydroxide in the boiler water concentrating in the dry areas. As long as the sodium hydroxide is in a dilute solution in the boiler water the water merely forms a thin impervious film of iron oxide which in turn protects the steel from further reaction with the water. When the sodium hydroxide concentrates in the dry areas the iron-oxide film is dissolved or penetrated by the concentrated sodium hydroxide, thus exposing the steel tube to further action with the water and the subsequent evolution of hydrogen. The oxygen from the decomposition of the water combines with the iron to cause the corrosion. If the metal temperature is not too high, the presence of silica tends to retard the action of the caustic solution. When sodium sulphate is present in relatively large amounts, it apparently precipitates as an insoluble salt and protects the steel from the caustic attack.

If the metal temperature is kept below 750 F the attack appears to be definitely related to the dry areas and the chemical composition of the boiler water. However, if the metal temperature is above 750 F, the attack occurs in the absence of sodium hydroxide and is not prevented by chemical treatment. This appears to explain the different conditions which have been found in different boilers. Thus if the dry areas occur where the metal temperature is below 750 F, the chemicals present in the boiler water would have a marked effect on the corrosion taking place. If the metal temperature in the dry areas should exceed 750 F, the corrosion will proceed in such a manner that chemical treatment will have practically no effect in preventing it.

The fact that the metal temperature in a dry area has to be controlled within such narrow limits would indicate that the prevention of corrosion in these areas is a mechanical problem and not chemical.

SUMMARY OF CONCLUSIONS

The results of these tests may be summarized as follows:

1 This type of corrosion occurs only in partially dry areas.

2 If the metal temperature is below 750 F, sodium hydroxide appears to be the active constituent in the boiler water causing the corrosion.

3 If the metal temperature is below 750 F, the corrosion may be controlled by modifying the boiler water as follows: (*a*) reducing the free causticity to zero, and (*b*) adding other salts such as sulphate, silicate, etc.

4 If the metal temperature is above 750 F, corrosion takes place in the absence of sodium hydroxide and chemical treatments effective at the lower temperature are no longer protective.

Engineering Developments in the UNITED STATES MERCHANT MARINE

By J. E. SCHMELTZER

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THE UNITED STATES MARITIME COMMISSION was created in 1936 by an act of Congress which states that "It is necessary for the national defense and development of its foreign and domestic commerce that the United States have a merchant marine (*a*) sufficient to carry its domestic water-borne export and import foreign commerce of the United States, and to provide shipping service on all routes essential for maintaining the flow of such domestic and foreign water-borne commerce at all times, (*b*) capable of serving as a naval and military auxiliary in time of war or national emergency, (*c*) owned and operated under the United States flag by citizens of the United States in so far as may be practicable, and (*d*) composed of the best-equipped, safest, and most suitable types of vessels, constructed in the United States, and manned with a trained and efficient citizen personnel. It is hereby declared to be the policy of the United States to foster the development and encourage the maintenance of such a merchant marine."

The Maritime Commission, in response to this mandate, has contracted for the building of 37 new vessels in its long-range replacement program of approximately 500 ships during the next ten years. This program is expected to result in an American merchant marine which will satisfy the needs of commerce and, at the same time, provide a vital adjunct to the U. S. Navy.

Because the purpose of this paper is to present a picture of the mechanical and engineering features of the ships being constructed and now being designed, descriptions of hull characteristics will be omitted except in those instances where factors pertaining to the ship's power plant are involved.

It is the Maritime Commission's policy, wherever possible, to follow any developments in the direction of increased machinery efficiency which may have come about in stationary-power-plant design for the purpose of adapting them to ship propulsion. The main factors that must be considered in marine installations are:

1 Economy of operation
2 Reliability
3 Simplicity of design and operation
4 Location of machinery in confined spaces, such as the engine rooms aboard ships
5 Weight
6 Instrument control, as far as practicable
7 Cost factors.

ECONOMY OF OPERATION

The present trend in marine steam engineering is toward higher pressures and temperatures, and, in this case, the marine industry is closely following the trend established by the stationary power plant. However, there are exceptions. The marine industry did not follow the power people into their development of the reheat cycle and, so far, the Mercury boiler and other such experiments have not been attempted in ship installations. But the marine engineer is closely watching the phenomenal thermal efficiencies the mechanical engineer obtains in these experiments. However, any design feature which aids in over-all economy and does not cause the power plant to lose other desirable features, most important of which are safety and reliability, will receive the most thorough consideration for installation on shipboard.

Economy of steam operation may be largely obtained in three places, namely, the boiler, the engine, and the condenser.

In connection with boiler installation on shipboard, it can be stated that the design of a boiler satisfactory to a stationary power plant has not proved itself generally satisfactory for use on ships, the result being that the manufacturers have developed a boiler of special design for marine use and this boiler, as it exists today, is a development that represents a combination of thought of both the marine-engineering and the mechanical-engineering profession. It can be fairly stated that without the cooperation that has existed between these two branches of engineering the steam power plant aboard ship would not be nearly as far advanced as it is. However, the mechanical engineer is, as you know, producing various types of flash boilers, trying out new binary cycles, and experimenting with combustion under high pressures. Marine engineers regard his progress on these lines with mingled hope and trepidation, knowing well that they will have to take his strange brain children and give them a seagoing education. The marine boiler is limited by practical and obvious considerations to the use of fuel oil in contradistinction to the widespread use of coal and natural gas in land practice. However, very promising tests have been made with pulverized coal on shipboard and, considering the relative safety and naval value of outside coal bunkers, it would seem that further study might be attempted in the bunkering, moving, pulverizing, and burning of coal.

RELIABILITY AND SIMPLICITY

The steam-engine problem existing in the marine field is not entirely one of developing turbines for high-pressure and high-temperature steam, because great progress has been and is being made by stationary power plants along these lines and this experience has been adopted to some extent by the marine industry. A few of the marine engineer's problems may be introduced at this point.

Since for hydrodynamic reasons the propeller shaft of a ship must run at a low number of revolutions per minute, it has been found desirable to install gearing of either single- or double-reduction type between the turbines and the propeller shaft in

Presented at a meeting in New York, N. Y., Nov. 9, 1938, of the Metropolitan Section of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

order to take advantage of the increased efficiency gained by operating the turbines at a higher speed. The reliability and, in particular, the size of marine gearing are beyond anything known in land practice. This is more interesting since marine machinery foundations have none of the rigidity considered essential for large-sized land units. In addition, due to mal-alignment and torsional-vibration problems, elements of flexibility, such as quill shafts, have to be introduced in the drive. There is another problem faced by the marine engineer which is practically without counterpart in stationary practice and that is the necessity of being able to reverse the main engines. This is one time the marine engineer regrets the passing of the day of the triple-expansion engine and the Stephenson link motion which had the problem of reversing so nicely solved. Today, reversing stages are generally mounted in the low-pressure casing, exhausting directly to the condenser. This arrangement, using the boiler steam at full pressure and temperature, gives enough power for backing, but introduces undesirable differential expansions in the casing and rotor, as well as sending hot steam to the condenser at times. Another problem is the fire hazard accompanying the use of high-temperature steam. The mechanical engineer is well aware of the risks involved when lubricating oil and fuel oil and steam fittings are close together. These risks are greatly accentuated by the confined space on shipboard and justify radical measures for their reduction. In this connection, any experience or suggestions of the mechanical engineer will be gratefully received and carefully considered by the Commission.

In regard to condensers, the marine engineer has faced a weight and space problem which he has attempted to meet with the use of smaller tubes and a higher loading by means of greater water-circulation speed through the tubes. This has brought its attendant difficulties. One unique departure from land practice is often made by using a scoop to produce the required head to move the circulating water through the condenser instead of a pump. Under these circumstances a stand-by pump is always installed for use while the ship is maneuvering. Another variation from land practice is that allowance must be made for the impinging of hot steam on the condenser tubes when reversing.

SPACE AND WEIGHT REQUIREMENTS

Space requirements, however, present the major problem of the marine engineer. A partial solution has resulted in the compact assembly of cross-compound turbines, double-reduction gears, and condenser, with the condenser located just below the low-pressure turbine to receive the drains, or in other cases, by triple-series turbines driving the propeller shaft through single-reduction gearing.

It is doubtful if engineers have gone as far as they should on weight reduction. Much of such weight reduction can be obtained by careful design, without sacrificing strength and rigidity, and by the use of various materials and alloys developed by the metallurgist.

It is true the mechanical engineer, whose province has been to work out satisfactory designs on marine units, has made his developments sometimes without regard to the limiting factors in ship construction. But when such has been the case, the marine engineer has shown him the defects in his design, and the result has been a power plant, which is highly satisfactory, although subject to further development.

The cooperation between the marine engineer and mechanical engineer is closer today than it has been at other periods. Before the world war the greater part of all of the main propelling machinery for ships was designed and built in the shipyards. The demands created by the war were beyond the capacities of the then existing yards, and the new yards which were created were assembly plants supplied with machinery built by manufacturers of other types of equipment, who in most cases built no marine machinery prior to the emergency. The marine industry has benefited and will continue to benefit by their entrance into the marine field.

INSTRUMENT CONTROL

An example of the marine-engineering profession's adoption of improvements initiated by mechanical engineers in power-house work is the use of combustion control. The marine engineer is, to a large extent, adopting the idea of automatic combustion control and developing it to meet the special conditions of the marine industry. At the request of the Commission, several types of combustion control will be installed in its ships so that, eventually, a set of such instruments, suitable for marine service, will be tested and evolved. The one danger in this is that the simplicity of marine installations may be unnecessarily injured. In too many cases the marine industry adopted gadgets to overcome some small difficulty which resulted in such complexity that it is difficult for the seagoing personnel to operate them properly, if at all.

COST FACTORS

At this point, mention is made of the controversial question of electricity on shipboard, which should be the subject of a paper by itself. The efficiency and cleanliness of electric motors has resulted in this form of power being used almost entirely to drive the important engine auxiliaries in the better type of merchant ships. The ships being built for the Commission are equipped with 120/240-v d-c generator sets. The motors for some pumps and blowers are arranged with variable-speed reductions as high as 50 to 66 per cent in speed. The chief disadvantages of direct-current auxiliary electrical machinery are cost and weight, and of alternating-current machinery, inflexibility and nonvariabl speed.

In regard to the even more controversial subject of electric drive for ships it may be said that weight and, to a much greater extent, initial cost make it difficult to recommend except where there is need of its flexibility and wide range of speed.

DIESEL OR TURBINE?

In foreign countries the Diesel engine is used more by the marine industry than the high-pressure turbine. At one time it seemed as though the Diesel engine with its high thermal efficiency would utterly displace the steam engine on ships, but since the advent of the high-pressure and high-temperature steam plant, the economic balance between the two types has become equal for ordinary size merchant ships and the type to be used in each case is decided on the basis of power, fuel costs, initial costs, reliability, service, weight, experience of ship's personnel, and the like. To digress a moment, the type of power plant used at sea depends upon size. From 50 to 500 hp the semi-Diesel or Diesel engine is supreme. From 500 to 2500 hp, it is again the Diesel with some competition from uniflow steam engines. From about 2500 to 10,000 hp, the longer routes favor the Diesel engine, and the shorter ones, below 3000 nautical miles, favor the turbine. Above these horsepowers the balance tips slightly and then completely in favor of the turbine, although there are some high-power Diesel-engine drives in use. It might be mentioned that in the higher brackets some designers prefer turboelectric drives to turbines and gears. Of course, this whole subject is highly controversial and in this day of rapid engineering advance any opinion is likely to become untrue almost as soon as spoken.

There is a trend in Diesel-engine installations at present toward engines of higher revolutions connected to the driving shaft through gearing rather than having the engine connected

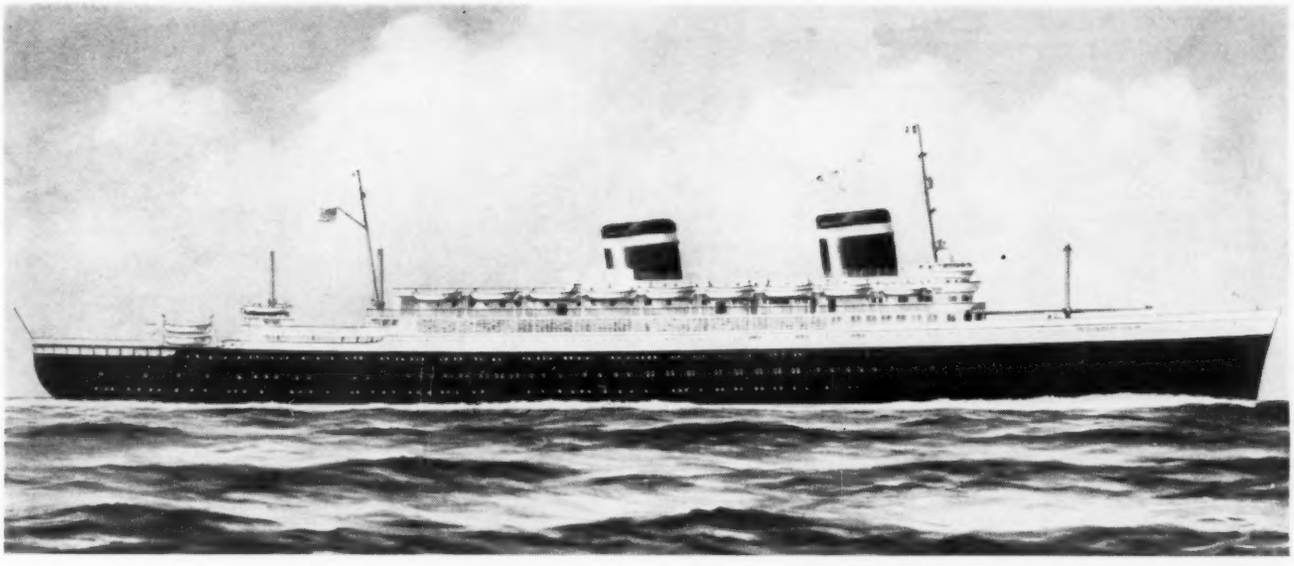

FIG. 1 THE NEW U. S. LINER AMERICA

directly to the shaft. This arrangement has some very decided advantages in its favor such as flexibility of power, less weight, smaller space requirements, and repairs made more easily without interruption of service. However, one difficulty to be overcome in such an arrangement is a more efficient means of connecting the engines to the gears.

The method most commonly used is the hydraulic coupling, but its use results in a considerable loss in power, greater weight, and the need of additional auxiliaries and equipment. Another means of effecting this connection between the engine and the gears is through an electric or magnetic coupling. It has not been used to any extent in this country as yet but seems to be in a fair state of development, although its use also results in a loss of power and addition of considerable weight as well as the requirement of a considerable span for its installation.

The mechanical flexible coupling overcomes the objections of loss of power, weight, and space, but it is subject to torsional vibrations which are of vital concern to the marine engineer. Considerable space could be given over now to the detailed discussion of the question involved in these types of coupling, but let it suffice to say that any real progress in Diesel marine installations must be accompanied by the development of a more satisfactory coupling. It behooves the mechanical engineers to expend a little "midnight oil" on this and not leave this problem child on the doorstep of the marine engineer for solution.

Leaving the problem of main propulsion, many other interesting engineering problems faced by the marine engineer can be considered. But attention will be directed toward one which has been successfully solved. The safety of ships at sea requires that they be operated under varied conditions of damage, even if the machinery compartment is flooded. So means have been provided for operating pumping units and other equipment, such as radio, lighting, etc., until help arrives. The operation of emergency bilge-pumping units has been solved by the installation of submersible pumps and at the same time putting remotely controlled valves in all important lines. Valves have been developed that can be operated either by air or hydraulically from a distant point or manually at the valve itself. The remote control of these valves is usually grouped at one station, which is well above the danger line of flooding, and from which the engineer can operate his pump machinery and draw water from any compartment of the ship that he desires.

SHIPS UNDER CONSTRUCTION

The ships whose construction has been definitely started, either for the account of the Commission or for that of an owner with the assistance of the Commission, are as follows:

1 A large passenger ship for the North Atlantic trade, the *America*, shown in Fig. 1, is scheduled for completion in the spring of 1940. It is a twin-screw ship of 34,000 shp. The driving units consist of two triple series of turbines driving the propellers through reduction gears. Mechanical reduction is from 3300 rpm at the high-pressure turbine through 1500 rpm at the intermediate pinion to 128 rpm at the propeller shaft. At intermediate- and low-pressure turbines the reduction is from 1500 rpm to 128 rpm at the propeller shaft. Six boilers supply steam at a pressure of 425 psi gage pressure and a temperature of 700 F at the superheater outlets.

2 The Commission has entered into a contract with the Standard Oil Company of New Jersey for the construction of twelve high-speed oil tankers which are now being built in four shipyards. The Commission's interest in these ships is in their increased speed, which is beyond that required for present commercial usage, but which would be of inestimable value in fleet operations. Each of these twin-screw tankers will have double-reduction-geared turbines of 12,000 shp which will drive the propellers at 96 rpm, steam being supplied by four boilers at 450 psi gage pressure and 750 F at the superheater outlets.

3 Four fast single-screw freight vessels for the American Export Lines are being built. Each, of 8000 shp, will be propelled by a propeller running at 96 rpm and driven by triple-series turbines through single-reduction gearing. Steam will be supplied by two boilers at 450 psi gage pressure and 750 F at the superheater outlet.

4 In addition to the afore-mentioned vessels, the Commission has entered into direct contracts with four shipyards for the construction of twenty cargo vessels known as the C-2 design. Half of these ships will have Diesel propulsion and the other half steam, with a normal requirement of 6000 shp, but capable of continuous operation at 6600 shp. The machinery and equipment are different for each group of ships at the various shipyards, in order to take full advantage of each shipyard's experience. In the case of the steam-driven vessels, six will have one type of turbines, gears, and boilers, made by one group of manufacturers, while four others being built at another yard will have a different type supplied by another group of

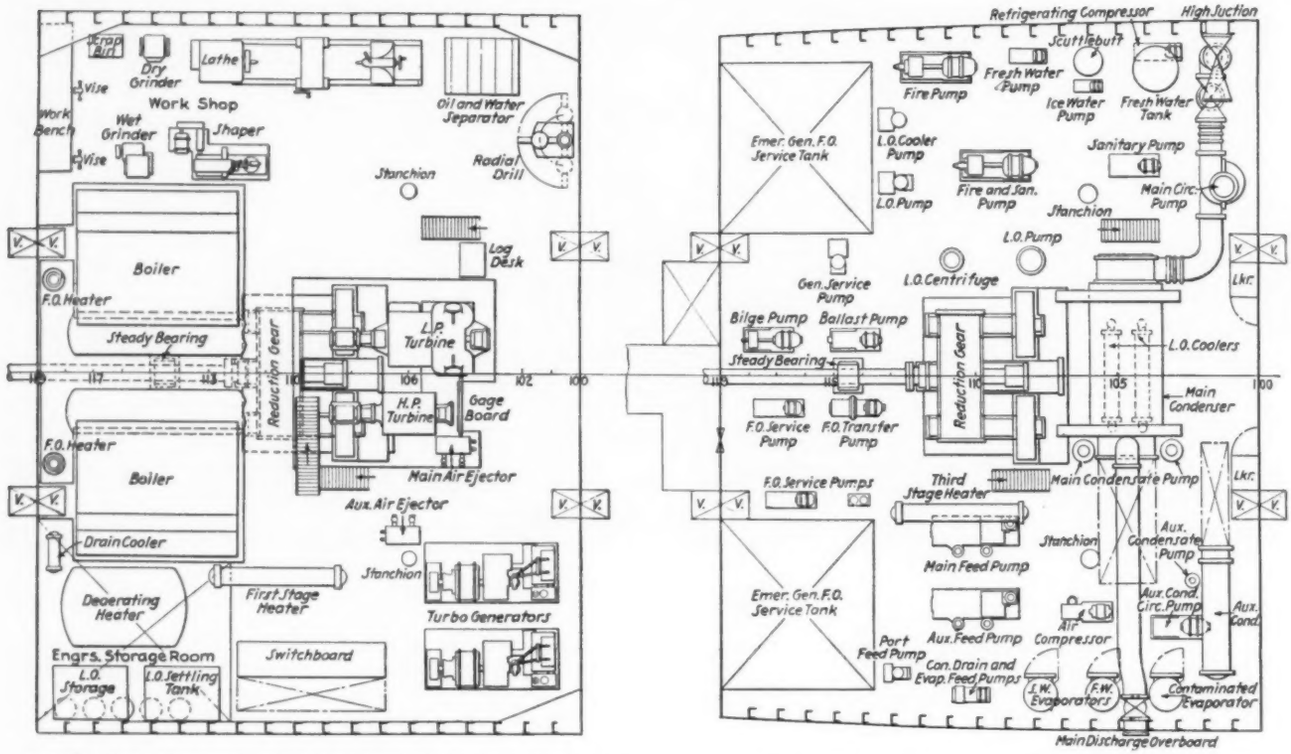

FIG. 2 ARRANGEMENT OF GEARED-TURBINE MACHINERY ON UPPER AND LOWER LEVELS IN THE ENGINE ROOM OF THE C-2 STEAMSHIP

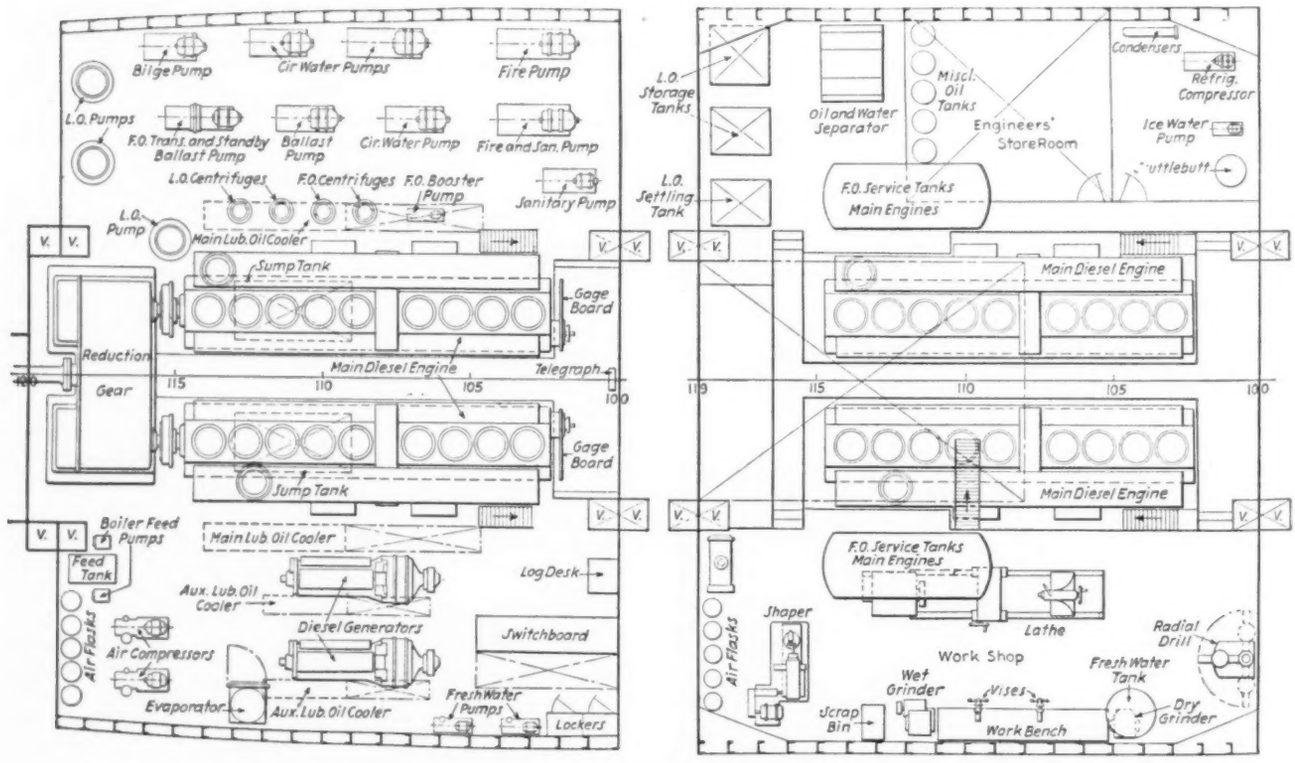

FIG. 3 ARRANGEMENT OF DIESEL ENGINES AND AUXILIARIES ON LOWER AND UPPER LEVELS IN THE ENGINE ROOM OF THE C-2 MOTORSHIP

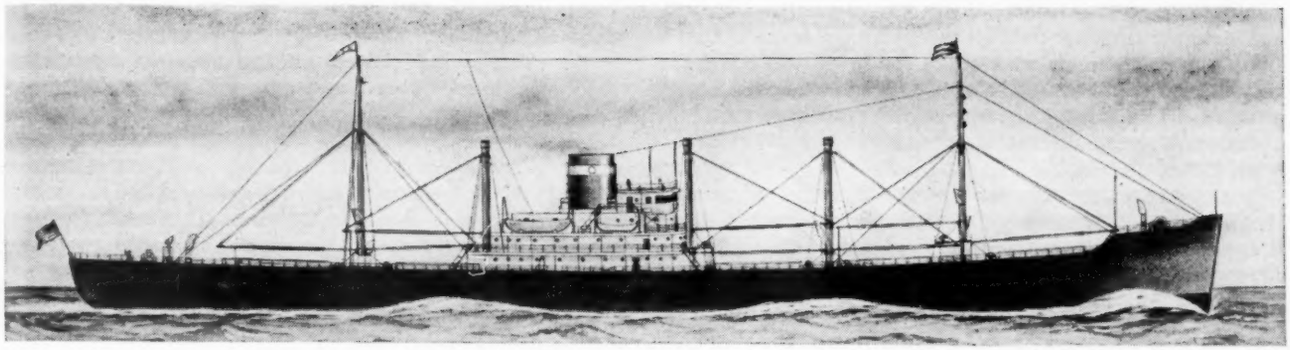

FIG. 4 DESIGN OF C-3 CARGO VESSEL

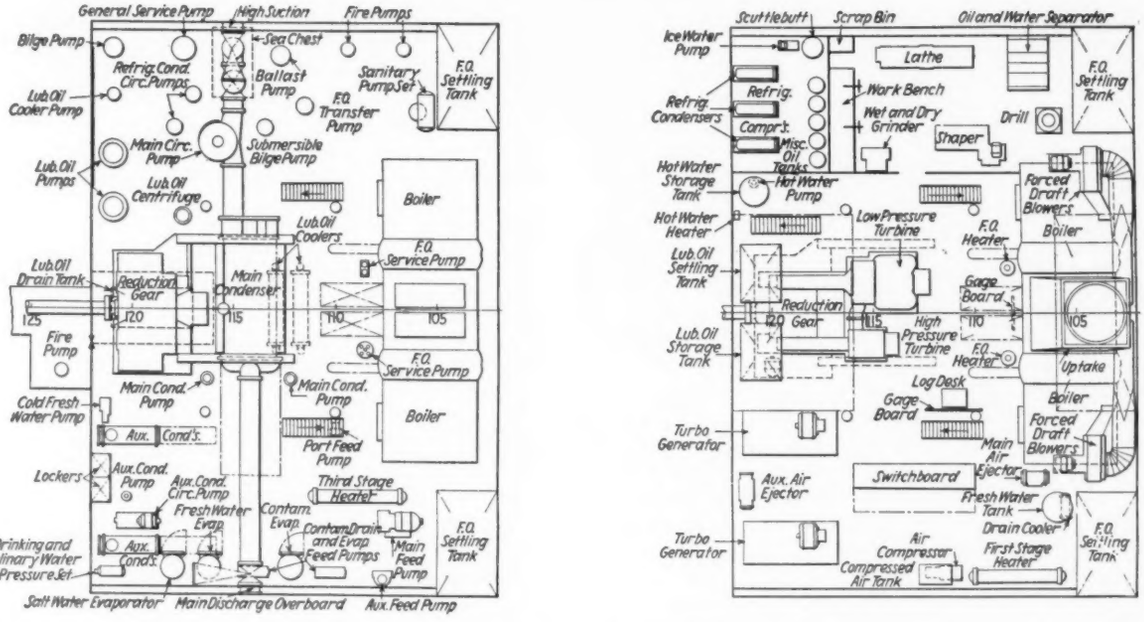

FIG. 5 ARRANGEMENT OF GEARED-TURBINE MACHINERY ON LOWER AND UPPER LEVELS IN ENGINE ROOM OF C-3 STEAMSHIP

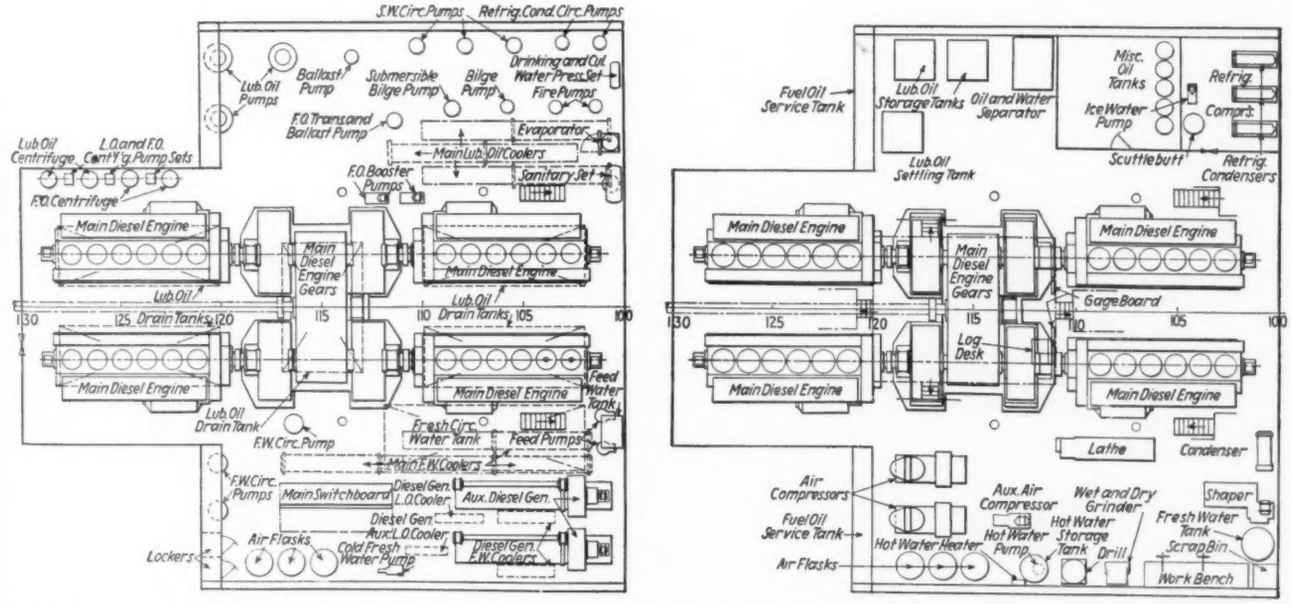

FIG. 6 ARRANGEMENT OF DIESEL ENGINES AND AUXILIARIES ON LOWER AND UPPER LEVELS IN ENGINE ROOM OF C-3 MOTORSHIP

manufacturers. These differences in equipment apply throughout the entire ship, not only for the main engines and the main auxiliaries, but also for the sanitary and hotel equipment, and deck machinery, and reflect the differences in engineering methods and opinions of the various shipyards in fulfilling the Commission's requirements in accordance with its specifications.

In the case of the Diesel ships the difference of opinion about design is even more pronounced. One shipyard will deliver to the Commission six ships equipped with slow-speed, direct-connected, opposed-piston Diesel engines. Another one is building four ships, each equipped with two high-speed engines, connected to the propeller shaft through hydraulic couplings and single-reduction gears.

C-2 STEAM POWER PLANTS

The nonextracting turbines of 6000 shp, when furnished with steam at 440 psi gage pressure and 740 F at the throttle, sea water 75 F, vacuum 28½ in., will have a water rate not exceeding 7.0 lb per shp. See Fig. 2. All turbines are equipped with suitable cross-connecting steam piping and connections which, when installed, will permit the individual operation of either high- or low-pressure elements, being a provision for emergency operation. A motor-driven turning gear, designed so that it can be easily engaged or disengaged, is included.

The guaranteed fuel consumption for all purposes on these ships is not to exceed 0.62 lb per shp per hour based on fuel oil having a calorific value of 18,500 Btu, but it is expected that the fuel consumption on the trials will be exceedingly better. The astern power will equal not less than 40 per cent of the ahead power.

Generally, the auxiliaries in continuous operation are driven by 230-v d-c motors, while some of the stand-by auxiliaries are steam-driven. The two 200-kw, 120/240-v d-c generators are driven by steam turbines. One generator is capable of carrying the entire sea load. In addition to the engine-room auxiliaries, the refrigerating plant, deck machinery, and fans for mechanical ventilation are all motor-driven.

There are two water-tube boilers fitted for burning fuel oil with forced draft and generating steam at 450 psi gage pressure and 750 F at the superheater outlet. They are equipped with desuperheaters capable of supplying steam at 450 psi gage pressure with superheat not exceeding 50 F. The guaranteed efficiency of the boiler must be at least 87 per cent.

A closed feed system is used on all of the Commission's steam-driven ships and deaerating feed heaters are used for removing oxygen from the boiler feed. In the circuit to the boilers the feedwater is drawn off from the main condenser hotwell, which is integral with the condenser, by a centrifugal, motor-driven condensate pump. This pump discharges through the inter- and after-condenser of a twin air ejector, being slightly heated by the drains of the air ejectors. The feedwater then passes through a drain cooler from which it receives additional heat and goes through the first-stage feedwater heater. This heater receives steam bled from the turbine at approximately 7.5 psi abs, and also steam from the make-up feedwater evaporator, with arrangements for an emergency supply of steam. The drains from this first-stage heater pass through the afore-mentioned drain cooler on their way to the main condenser. The feedwater next reaches the deaerating or second-stage heater which is a spray-type closed open-type heater equipped with a vent condenser. This deaerating unit has a ten-minute storage capacity, and heats the feedwater to about 240 F, using bled steam, auxiliary exhaust, drains from the make-up feedwater evaporator, and the third-stage heater. The feedwater after passing through the deaerating heater should not contain more than 0.03 cc of oxygen per liter on its way to the feed pump. The third-stage feedwater heater, which now receives the feedwater, is of the high-pressure type and is heated by bled steam from the turbine at a pressure of 100 psi abs, and the drains from the contaminated water evaporator. The feedwater then passes to the boiler at a temperature of about 318 F. The third-stage heater is only used when an air preheater is installed. In the ships with economizers only, the third-stage heater is omitted and the water enters the economizer at 240 F.

In order to keep the main feedwater system free from contamination there is installed a separate system known as the contaminated water system. An evaporator, supplied with desuperheated steam at reduced pressure, generates steam from the drains of the fuel-oil heater, the quarters heating, and the fuel-oil-tank heating coils which drain to a contaminated water tank. The contaminated water feed pump draws from this tank and supplies feedwater to the evaporator.

Boilers are installed in the same compartment with the main propulsion machinery instead of in separate spaces as was done formerly. This results in shorter lengths of steam piping and permits the officer on watch to observe all the principal units from the main operating station. The boilers on the C-2 design are on an elevated flat above the turbines. This arrangement is a forerunner of the ultimate development of a completely integrated and self-contained power unit.

C-2 DIESEL POWER PLANTS

Two main types of Diesel-engine drives are used on the C-2 ships ordered or proposed by the Commission. In the first type, a set of relatively high-speed two-cycle single-acting Diesel engines are connected to the propeller shaft through hydraulic clutches, and gearing, using a common bull gear. See Fig. 3. In the second type, a single, comparatively slow-running large Diesel engine of the opposed-piston type, is connected directly to the propeller shaft. Each of these types of power plant in the C-2 ships develops a normal shaft horsepower of 6000.

In each case there are two Diesel-driven direct-current auxiliary generators, each generating 215 kw at 120/240 volts. One generator will carry the sea load. The auxiliaries are all electrically driven except the boiler feed pump for the waste-heat boiler which is steam-driven.

The reason for the geared Diesel-engine design is the same as that for the geared turbines; a smaller and lighter high-speed prime mover can be used and the speed reduction maintains the propeller efficiency by keeping the propeller speed low.

The main propelling unit consists of two nine-cylinder, single-acting, direct-reversing, crosshead-type Diesel engines connected to the main propelling shaft by means of single-reduction gears. The engines have a 21-in. bore and 29-in. stroke and operate normally at 225 rpm, giving a piston speed of 1087 fpm. The cylinder jackets are cooled with fresh water and the pistons with lubricating oil. Each crankshaft is attached to a driver half of a hydraulic coupling and the two driven halves are each on a shaft integral with pinion meshing with the same bull gear. The reduction gearing is a self-contained unit, having provision for storing, circulating, and cooling the lubricant which is of the extreme-pressure, lead-oleate type. This lubricant is circulated and distributed to gears and bearings by means of a controlled splash system.

The control of the propelling unit is very flexible, allowing one engine to be operated alone by draining the hydraulic coupling of the other engine, or providing interlocking control when both engines are running. There is a waste-heat boiler heated by the engine exhaust, combined with a separate oil-fired boiler for use when in port to provide heating steam at 50 psi. This water-tube boiler also acts as an engine muffler.

(Continued on page 221)

Present-Day Popular ECONOMIC THOUGHT

By G. W. STARR

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I AM SURE that anyone who was a student of economics some years ago might well get the impression from reading our daily press that the science of economics has undergone significant changes within the last decade. As a matter of fact, we know that most of our economic theories which we thought sound a decade or more ago have not been shown otherwise because of our national experimentation. But let us remember that the science of economics lacks the large body of uniform rules and measures which form the background of some of the physical sciences. Consequently, in many sectors of the field of economics there have been several schools of thought.

For years many of our economic theories had remained matters of academic discussion only, with no possibility of being tried out on a national scale. Such ideas as high wages, pump priming, production restriction, and price fixing, as accelerators of recovery, were some of the untried theories over which there has been much cleavage in our academic thinking. Even voluntary devaluation as an automatic price-raising device and as a collateral means of reducing the debt burden of the individual had not been tried in modern times for these express purposes. Until some of these economic concepts had been given a trial on a larger scale than had heretofore been found possible, their validity had to be accepted largely on faith.

With the zeal for experimentation which broke loose in the United States following the conditions of 1932, an opportunity was afforded to test some of the disputed theories. With the knowledge that our government was willing to try certain theories of stimulating recovery, everybody became an economist and submitted his way out. It is natural that under conditions of this kind all that was submitted was not economics. It also seems evident that everything selected for trial might not work. I need not point out that everything did not work. Valid recovery schemes for one sector of our economy were bound to become enmeshed with equally valid schemes for other sectors when all were applied simultaneously. The difficulty of increasing the farmer's purchasing parity by increasing both agricultural and industrial prices by relatively the same amounts is apparent to anyone.

ATTEMPTS TO APPLY THEORIES ABOUT RAISING PURCHASING POWER

The objectives of our economic experimentation of recent years as nearly as they can be identified have been to raise purchasing power, and once raised to stabilize it, and lastly, provide some measure of redistribution. The emphasis on the different objectives has not always been the same, nor the methods used always consistent. But in the main our recovery movement has been a series of monetary and nonmonetary experiments of the purchasing-power theory of business recovery. Not only has the government tried different variants of the purchasing-power theory of recovery but all sorts of minority groups have advocated different versions of the theory, which has been present in nearly every short cut to recovery from the devaluation of the dollar to the latest version of the "thirty-dollars-every-Thursday" plan. Persons high in authority in the federal government, persons with enough formal training to be considered economists, farm-organization leaders, pension-plan advocates, and many labor leaders have advocated some adaptation of the theory in their particular method of saving the country.

Let us take a look at the results of the practical application of some of our theories about raising the purchasing power of our people. Historically in the process of national experimentation, the devaluation of the dollar came first. Both great and terrible things were predicted because of the abandonment of gold and the subsequent marking up of gold in terms of the dollar. On the one hand devaluation was to raise prices in ratio to devaluation, make outstanding debts less by the same amount, and give us a dollar whose purchasing power would not change appreciably. On the other hand it was predicted that devaluation and the abandonment of the fixed relationship between the dollar and gold which had existed since 1879 would lead to uncontrolled currency inflation. It is not entirely inaccurate to say none of these has happened. Prices rose in the United States after devaluation, but to a large extent from causes quite apart from devaluation. Debts were not easier to pay by the amount of the decline in the gold value of the dollar, because debtors were not holders of gold which appreciated through dollar devaluation. Dollar debts within the United States were still payable in dollars. The purchasing power of the dollar has been no more stable because of our monetary policy than it was in the days under the old gold standard. There is much ground for the belief that it has been much less stable than it was prior to our abandonment of gold.

It must be recognized that much of such price stability as we have had has not been due to monetary causes. The artificial stabilization machinery present in the various price-fixing laws, the setting up of regulatory machinery for price maintenance, such as the Bituminous Coal Commission, and the work of the Department of Agriculture in pegging farm prices, have contributed more to the stability of our wholesale-price indexes than has our monetary policy. I am sure if the prices of farm products had not been propped up by the various devices available to the Secretary of Agriculture, the prices of the principal farm crops within the last few months would have dropped to the 1932 level. It is safe to say that taken alone our monetary policy has in no way stabilized the purchasing power of the dollar. Likewise there has been no runaway commodity-price inflation because of our monetary policy, as was predicted by some of our well-known economists. I think that in the long run we probably will not escape uncontrolled inflation, but it will not be the direct result of our gold policy of the past. One result of our devaluation policy was to bring international price levels into something like an equilibrium. Yet it was not our policy alone that did this, although we may have supplied the momentum. There have been other adjust-

Presented at a meeting, Kokomo, Ind., Oct. 12, 1938, of the Central Indiana Section of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

ments in relation to gold by other countries since our devaluation.

Many international price relationships were out of line from 1932 to 1936. At the end of 1936 they were fairly well back in line, but since that time they have again spread. Just as there was a basis for devaluation by the leading countries from 1931 to 1934, it now appears a basis is being established for the upward revaluation of the principal currencies. Our gold supplies are becoming just as excessive as they were inadequate a decade ago. Our present problem is no longer one of a scarcity of monetary gold, but of the distribution of our gold stocks. Devaluation in no way has improved the distribution of gold among the nations of the world; if it has had any influence it has been to aggravate the problem. Our experience in the meantime seems to indicate that in theory currencies might be managed to stabilize the price level, but that in practice nothing of the kind will happen in most countries. Purchasing power may be affected by monetary experimentation but probably not regulated so as to stabilize it.

DOES GOVERNMENT SPENDING RAISE PURCHASING POWER?

The expansion of public works, pump-priming if you wish to call it that, has long intrigued economists as a device to expand purchasing power during periods of depression or recovery. The belief that purchasing power could be raised in relation to industrial output through the process of having large portions of our population engaged in nonproductive work in periods of subnormal business has long been a popular recovery theory among many of our economists. Most theories assume that the best sort of nonproductive work is the building of public works financed by the government. It is true that some public works are in a limited way productive, but the output of goods or services in relation to the total investment in our whole public-works program in no way can be considered significant. It is assumed that a large program of public works would increase consumers incomes without bringing about a corresponding production of consumers goods. If this were true it appears it might follow that there would be a rise in consumer prices and consumer demand. There is nothing wrong with the abstract theory, but in practice it may bog down miserably.

Government spending to be effective in bringing about recovery must encourage private spending. That government spending is temporary and the artificial support may be withdrawn at any time may cause business to be more hesitant than ever in making outlays for improvements and extensions. Again, a program of government expenditures may peg the very prices which should decline to bring about a recovery. It must be admitted that in a depression the price relationships are out of joint, or no depression would have occurred. A large program of federal expenditures may prevent a decline in the costs of building materials and labor necessary for a revival of the capital-goods industry. The building program of the government within the last ten years at times has had the effect of freezing prices and costs which should have declined.

Then, in order to be effective, all parts of a recovery program must be such as to engender confidence in the outlook. This has not always been the case recently. Thus, inasmuch as our public-expenditures program has not been directed toward a reduction in costs and has not always been accompanied by other policies intended to encourage business expenditures, we have not had a fair trial of public expenditures as a recovery measure. This much we can see: The rise in the public debt from less than 17 billion dollars in 1930 to close to 40 billions by the end of the current fiscal year had reduced our unemployment from 14,000,000 persons to 10,000,000. Thus, if the government expends $2^1/_2$ billion dollars for capital goods in a year, private industry must spend 14 billion dollars to bring our unemployment down to something like a normal figure of, say, around 3,000,000 persons.

Another factor in our public-expenditure program which must be considered is the matter of timing. The cumulative results of our expenditures under the flexible budget which apparently will exist as long as we operate under a substantial deficit may come at a time when they are not needed, and they may only aggravate a boom. For example, the payment of the soldiers' bonus might have been helpful if it had come in 1937, but since it came in 1936 it had a part in creating the depression of 1937–1938. Here, then, is a theory of increasing consumer purchasing power which may be helpful during times of depression if carried out under, let us say, laboratory conditions. But we need also be reminded that in a democracy laboratory conditions rarely exist in practice, and any theory which we should attempt to put into practice must be presumed to be workable in a democracy.

PRICE FIXING AND FAIR-TRADE LAWS

In recent years there seems to have been as much popular belief in nonmonetary as in monetary methods of raising prices. Such plans as the NRA, the AAA, the Bituminous Coal Law, state and national fair-trade laws, the oil-prorating laws, are a few examples of nonmonetary attempts at price raising. The rigidity which these methods of price fixing or control have introduced into our economic system is almost unmeasurable. There seems to be a belief in certain quarters that if we could make it illegal for anyone to do business at a loss, or at least not below a given margin of profit, business would be forever stabilized at a profitable level. Not the least harmful in this belief is the unlimited faith some people have that cost determines value. If this is true, then all we need to do is determine our cost, add a fair margin of profit, and we have the price at which everything should be sold. It is unfortunate for us that all those who share this faith in cost have not in recent years been the sole owner of an interurban railway. It has been this naive faith in costs as a basis of price, as much as anything, that has been responsible for the wave of fair-trade laws which has swept the country. Ostensibly, the purpose of the fair-trade laws has been to eliminate unfair competition. No one objects to the elimination of unethical and unfair methods of competition. But any competition has been regarded as unfair in some quarters, and the ideal seems to have become that cost should be determined by the high-cost firm in the association or industry, and any sale below this cost is unfair and unethical. I need not elaborate the ends to which this kind of thinking will ultimately lead.

I think the lessons of the NRA would have been well worth their cost if they had taught businessmen that the concept of "self-governing industry" is but a pipe dream. In a democracy private monopoly cannot be left free to fix its own prices without rigid public control. Likewise, private monopoly, fixing prices, whether because of the domination of the industry, or through codes, associations, trade agreements, or what not, will not be free for long if it comes under political dictatorship. And political dictatorship over industry is inevitable if business big and little avoids conditions which will give us free competition and free markets. Nor are those in political positions, or those who would like to be in political positions, entirely ignorant of the power without responsibility which would accrue to them under a system of regulated monopolies. I think that the theory that competition is not satisfactory under our present stage of industrial development and that it should be supplanted by some form of "self-governing industry" is being dissipated rather rapidly.

Out and out price fixing or price pegging by the government

either with or without production control is something slightly different from permissive price fixing through fair-trade laws. Price fixing is unfortunate in any event. Even among the public-utility industries free competition would be ideal if the industries were so constituted that free competition would not become ruinous and clutter up our streets with duplicated facilities. As it is, we must have either government or private monopoly with fixed prices in the utility industries. In agriculture, price fixing through one device or another may be justified as an emergency measure. There is always grave danger, however, that we may create a permanent emergency. In some respects this is what is slowly happening in some parts of our farm economy. Price fixing through production control or other means may exclude us from some of our foreign markets for such a period that those markets will be lost to us permanently.

Temporarily, there may be advantages to production control, especially for those industries, principally agricultural, in which the demand for the products is quite inelastic. It may result in directing a larger portion of the consumer's expenditures into the direction of the products for which his demand is inelastic and less into the elastic commodities. But nothing spectacular should be expected from production restriction because the large unexpended balances during a period of depression are not in the hands of the consumers. If they exist, they are in the hands of business enterprises.

In our price-fixing endeavors we have developed some strange philosophies. We have assumed that those who own mortgages are very wealthy and those who owe on them are very poor. There may be instances where this is true, but as a general proposition it cannot be defended. In some cases we have allowed industries who have been indiscreet enough to become involved in long-time mortgage obligations to exploit the consumer through high prices because of this condition—a partial plan to tax everybody to keep everybody in business.

WILL HIGH WAGES INCREASE PURCHASING POWER?

Next to our faith in price fixing and price raising as a means of restoring prosperity must be placed our belief in high wages as a means of increasing consumer purchasing power. Now there is no quarrel with high wages in themselves. High wages and low costs would be a fine condition, but, unfortunately, under many situations, also an impossible one. We know that both real and dollar wages over long periods have moved constantly into higher ground with the only temporary declines during periods of business depression. Wages also are the only part of our cost of doing business which the wage earners and the public at large feel should not decline but always move upward. There are valid reasons for this belief, and I will discuss them presently. On the other hand we have overstressed the importance of wages in periods of recovery and depression. We have assumed too often that the wage earner is the only person buying consumer goods. The best studies available show that the number of stockholders, eliminating duplications, is beyond 12,000,000 while the number of book stockholders is close to 36,000,000. Our total wage earners number somewhat more than 40,000,000. In this connection it may be pointed out that several of our very large corporations have more stockholders listed on their books than employees in their plants. I do not want to minimize the importance of the wage earner, but in our discussions of purchasing power we have been inclined to assume that consumer buying power depends solely upon the wage earner.

But aside from the statistical importance of the wage earner as a consumer there is another important angle to the high-wage theory of business recovery. If the high-wage part of our purchasing-power theory is valid, then one of our principal theories for the decline of business during a depression is wrong. It has been fairly well established that one of the causes of business depressions under our present system of organization is that costs outrun prices and profits. Now wages cannot be both a self-starter and a brake on our business machine, they must be one or the other.

The theory that general wage increases will restore prosperity assumes that the immediate results of higher wage rates will be larger total disbursements to labor, and that the communities' expenditures for goods will increase by more than the disbursements to labor, so that industries may pass on to the consumer the entire increase in labor costs in the form of higher prices. Actually, there is no evidence that anything like this happens or that it is reasonable to expect it to happen. Business revival depends largely upon business spending, and it is business spending upon which consumers depend for most of their income.

To increase business spending it is necessary to reduce costs. Interest costs, wages, taxes, etc., must be reduced. In short, it is the profit outlook which guides the outlook for business and the amount which it will spend. If costs are reduced more rapidly than prices, the outlook improves and business expands, and we may presume that it contracts when profits disappear or drop to a minimum. We had an excellent example of this in 1937. Business in 1937 declined while profits were still rising. However, businessmen saw that the profits on new business were declining because of, among other things, the rising cost of production.

WHAT IS PURCHASING POWER?

Thus far I have discussed some of our popular theories which have not worked. One may well raise the question whether there are no theories which will work. The difficulty thus far has not been so much in the theories as in our understanding of them and our application of the theories in practice. I think it would be helpful if we made a more intensive study of this thing which we call purchasing power. If we could divorce purchasing power from money I think we would have a much better understanding of what we mean by the term. Unfortunately, purchasing power has long been expressed in terms of its measure, that is, money. As a result of this association, we have come to regard the measure of purchasing power as the purchasing power itself. We have come to treasure the yardstick more than that which it measures. If we can substitute exchangeability for purchasing power, we can have a much better designation of what we are all talking about. Purchasing power can be measured in any unit—land, commodities, index numbers, and many other ways. Our purchasing power is the amount of exchangeability we can develop with reference to ourselves or anything we possess. Two communities may have a surplus of commodities, one, say, hats, and the other shoes. If they have only these commodities and no means of communication or exchange with each other they have no purchasing power because of the impossibility of any exchange. Give them means of communication and they have purchasing power. Surplus hats may be exchanged for shoes. Neither the commodities nor the means of communication is purchasing power, but the combination has given both communities purchasing power. Thus, whether we are using gold coin or peanuts as a medium of exchange it is the condition of maximum exchangeability that creates maximum purchasing power. Break down the exchangeability of our persons and purchasing power declines irrespective of the amount of money which may be available. This has been a factor which has been overlooked in many of our purchasing-power theories.

In so far as our domestic and foreign policies have been in the direction of increasing exchangeability they have been in the

direction of increasing purchasing power. When I say "our" I am thinking not of the United States alone, but of the world at large. The present exchange agreements and trade compacts, in so far as they afford a better ground for the exchange of goods, should increase purchasing power. In this connection it should be noted that a maximum of exchangeability can come about through having a maximum of goods to exchange. This means that our standard of living can only rise through increasing the amount of goods over which the average individual can get control. Thus, for the rank and file of our population, a few goods at high prices, even with high wages, are not the same as large quantities, or perhaps I should say many kinds, at lower prices.

TECHNOLOGICAL PROGRESS AND EMPLOYMENT

This brings us to another popular theory or fear: That we are becoming so highly organized that the opportunities for employment are being wiped out by technological progress. This our old friend Technocracy. There are many varieties of this underconsumption or overproduction theory. I shall not explore each one.

The dangers in this direction are greatly overdrawn. The principal offenders are those who learn of a particularly efficient plant in an industry and then assume that the whole industry is organized on this basis, or soon will be. As a matter of fact, there is a wide variation in industrial efficiency. An industry at a given time represents plants ranging from those with high capital costs and low labor costs to those with very low capital costs and high labor costs. The latter naturally take up the slack in the industry. They come into production at the peak and pass out at the bottom of the business cycle. Or if not this, the volume of the total which they produce varies greatly with the intensity of the demand. These plants represent a reserve in our production capacity.

Furthermore, we know that the wants of man are almost insatiable. Evidence of this is the large amount of our present employment which is in those industries unknown ten, twenty, or thirty years ago. For those industries having a product which has an elastic demand, increased output through more mechanization generally means increased rather than diminished employment. In the industries for which the demand is inelastic, increased mechanization may mean less employment. I am inclined to think in the field of manufacturing that the number of elastic industries far exceeds the inelastic ones. It is true that technological development does cause temporary maladjustments in employment and it is a problem which we must face. But let us not overestimate its importance and assume that it can be remedied by stopping progress altogether. The proposals given to the last Congress to limit or tax labor-saving devices is too absurd to need any discussion.

There is, however, an angle of the technological problem which I do wish to discuss. If we are to have a minimum of technological unemployment, it will be necessary that industries pass the benefits of the improvements on to the consumer as rapidly as possible, either through lower prices or better products. Some of our present technological unemployment might disappear if more of the benefits of improved methods were passed on to the consumer. But our present unemployment problem is not technological.

ECONOMIC SYSTEM NEEDS MORE FLEXIBILITY

I think most economists are in agreement that our economic system needs more flexibility. The failure of costs to remain down in 1937 when prices were dropping and orders were declining was to a large extent responsible for the decline in late 1937 and the first half of 1938. With wage costs much higher than in 1929, and prices some 10 per cent lower, the profit margins soon dried up. Costs could not drop so rapidly as prices or profits. With production some 15 per cent above 1924 and profits 40 per cent lower, it was little wonder that new capital did not flow into industry. Corporate expansion, and the advance of the new over the old, comes about through the investment of risk capital. Risk capital will not come out without some reasonable chance of a return and assurance of some stability in the future. These factors were notably absent in 1937. In the way of stability reasonable assurance of comparative freedom from unreasonable interference on the part of the government on one hand and labor on the other is all that risk capital asks.

There is no doubt but what the recent organization of labor in many industries has increased the inflexibility of labor costs. Inflexible labor costs delayed recovery in Great Britain following the war. Eventually, Britain solved her labor difficulty. In the United States flexibility in wages will have to wait until labor is fully organized and, as such, appreciates the necessity of more flexibility in wage rates and hours. I see no chance to accomplish this until the present controversy over the organization of labor is settled.

In the past labor has with considerable right objected to wage decreases and wage adjustments. The history has been that it is much harder for labor to get its wages raised than reduced. Likewise, in many cases labor was the only part of the cost of production that underwent any appreciable change. Other items, the return to the investor, the income of the bondholders in particular, underwent no change. I am not overlooking the fact that bondholders' incomes also underwent no changes on the way up. The point is, if both fixed charges and bond interest could be varied with wages, more flexibility could be introduced in the handling of business costs, and wage earners would be more agreeable to frequent adjustments in wages. It is just a theory, and like some which I have discussed already, may have practical difficulties. I think the proper handling of our unemployment reserves could increase the flexibility of our economic system. Unemployment benefits are a proper charge against our economic system. As they are being handled they can have only one effect on our economic system—that of increasing the intensity of our booms and depressions. If we made the Reserve Banks the depositories for the unemployment reserve funds and required the trustees of the funds to deposit them with the Reserve Banks, the effect of the reserves would be toward more stability in our economic system. Credit would be contracted during prosperity and expanded during depression. The present system has just the reverse effect upon our credit system.

In brief it appears to me that the opportunity for business both in the United States and abroad is to work toward more flexibility. I must admit that the trend for more than a decade has been in the other direction. Governments in some instances are responsible for this trend; in other cases it has been governments and business combined; and in still others it has been largely business alone. Labor organizations too often have helped in this direction. Unless we move in a direction of increased flexibility in our economic system, the outcome appears to be a drift in the direction of a lower standard of living. If businessmen large and small, in nearly all fields of distribution and production, and even finance, could see that the more flexibility we get into our system through the elimination of price maintenance, or the removal of the limitation of unfair competition which in many cases is not unfair competition but simply competition, and if labor organizations could see that price maintenance, production restriction, and price fixing in the long run is not in their interest, many of the impediments to a higher standard of living would be removed rather rapidly.

Personal Reflections on Forty Years of DIESEL-ENGINE DEVELOPMENT

By ALFRED J. BÜCHI

WINTERTHUR, SWITZERLAND

AS FAR BACK as 1898, I made my first acquaintance with a Diesel engine and its inventor, Dr. Rudolf Diesel, in the Sulzer plant at Winterthur, Switzerland. I was an apprentice and my father, who was works manager, gave me the opportunity of being present at the testing of the first Diesel engine built by Sulzer and permitted me to operate the brake on this newcomer in the prime-mover field. After testing the engine for several weeks, the company called a halt to the tests for a time. My first and subsequent meetings with Dr. Diesel are described later in this narrative.

From 1899 to 1903, I was enrolled as a student at the Swiss Institute of Technology where I had the pleasure of studying thermodynamics, steam engines, and steam turbines under Professor Stodola. The Institute's laboratory contained only a gas engine and an oil engine of the hot-bulb-ignition type. We learned little or nothing about internal-combustion engines; however, Professor Stodola insisted that we work out every thermal process not only with steam, but also with air and various kinds of fuels. To assist us, he had developed a gas-entropy chart which did not take into account the change of specific heat and the chemical analysis of the changing gases during intake and combustion of the fuel.

In 1903, I went to Ghent, Belgium, to work for Carels Brothers, a firm famous for its manufacture of poppet-valve steam engines, locomotives, and Diesel engines. These Diesel engines were all small units—from two to four cylinders—and operated with air injection of the fuel. This was accomplished by having a pump exhaust the air from the cylinders just before top dead center at about 100 psi. Since this method was not entirely satisfactory, two-stage air-injection pumps, having a system of cooling between and after the two stages and drawing in air directly from the atmosphere, were used later.

EARLY DIESEL-ENGINE DIFFICULTIES

Many difficulties were encountered at that time with Diesel engines.

(*a*) *Air-Injection Pumps.* Since the valves were exposed to very high temperatures, they had to operate rapidly. Being similar to valves with conical seats, they were also too heavy. Later, dashpots were used to minimize the inertia forces at the stopping points. After further experimentation, plate valves were developed and worked with better success.

(*b*) *Heat Troubles.* The piston crowns burned out with higher mean effective pressures. In an effort to overcome this difficulty, a costly platinum plate was inserted in the center of the piston head. After the engine, in which this very expensive piston had been installed, had run for some time, it was dismantled and the platinum plate was found to have completely disappeared. Of course, this incident put a complete stop to further experimentation with platinum piston tops.

(*c*) *Operation.* It was very difficult in the old days of the supremacy of the steam engine to find suitable Diesel-engine operators. The steam-engine manufacturers put up a stiff fight against the still young and weak industry, and the sale of Diesel engines encountered innumerable obstacles. Most of the Diesel engines manufactured by Carels Brothers were, curiously enough, sold to the coal country, England, and her colonies.

The company was not very well pleased with the results obtained from the great amount of money it had expended for all the development work and the costly servicing in the field. It was, therefore, wondering if it were on the right track in building Diesel engines, and consequently, proposals for other types of engines were seriously studied.

ADOLPH VOGT'S DESIGNS

An Austrian engineer, Adolph Vogt, made several interesting proposals, and I, a young engineer, was asked to make the necessary drawings and to carry out the tests. His first idea was that if the compression ratio in an internal-combustion engine could be changed and suitably adjusted according to the load and speed of the engine, the high compression would result in the best thermal efficiency.

A test gas engine of the horizontal type, shown schematically in Fig. 1, was accordingly designed and built. Below the compression space was a small receiver which was filled with water by means of a nonreturn valve during the suction stroke of the engine. A spring-loaded overflow valve permitted the escape of a certain amount of water, depending on the pressure for which the spring was adjusted by hand or by the governor.

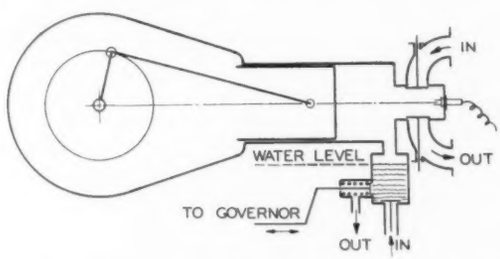

FIG. 1 VOGT'S VARIABLE-COMPRESSION ENGINE, 1904

The test showed that the compression could be adjusted, but an unforeseen incident occurred. When the pressure dropped during the exhaust stroke, the water in the receiver began to evaporate rapidly, and continued during the suction stroke so that the cylinder chamber was partly filled with steam, and consequently the volume of fresh air and gas was considerably reduced as compared to a normal gas engine. This reduction in intake and volume amounted to about 40 per cent, so that only 60 per cent of the normal output of this water-compression engine could be obtained.

Another Vogt design was an internal-combustion water-column engine. A large unit of a supposed output of 1000 bhp was built. It was a horizontal double-acting gas engine, as shown in Fig. 2, with a cylinder which was partly filled with water;

Presented at Peoria, Ill., Aug. 18, 1938, at a regular meeting of the Central Illinois Section of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

there was no external water cooling at all. At the compression dead-center position of the piston, the water level was high so as to give a high compression to the charge. When the piston was at the scavenging dead-center point, the water level was far down and the exhaust gas was scavenged out through exhaust valves which were under water during combustion and a great part of expansion. The scavenging air entered at the top of the compression space through a combination air-gas valve, which, as was quickly found, had to be operated pneumatically, that is, by air pressure, because it could not be actuated rapidly enough by mechanical means. Our opposition to this scheme was that this engine would never run at the proposed speed of 125 rpm on account of the inertia forces of the water columns set up by the speed of the engine. Another objection was that

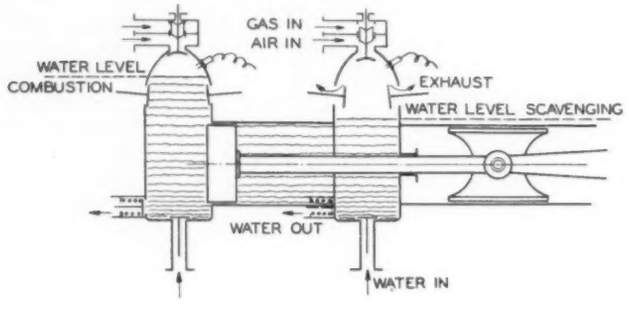

FIG. 2 VOGT'S WATER-COLUMN ENGINE, 1905

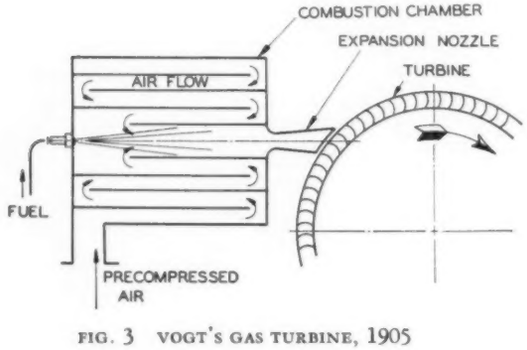

FIG. 3 VOGT'S GAS TURBINE, 1905

the water thrown up would disturb and spoil the combustion, not to speak of the inoperation of the drowned spark plugs. The engine ran satisfactorily at low speeds but above 55 rpm the firing ceased and a higher speed was impossible. The speed obtained was, of course, too low to make the engine of commercial value.

Vogt's third design was a gas turbine. He sought to overcome the difficulty of the very high temperatures on the turbine blading by adding the combustion air through a preheater combined with the combustion space ahead of the turbine, as shown in Fig. 3. The incoming air from the compressor was led through passages to the burner where it would absorb the heat dissipated by the combustion gases. The tests proved, however, that the volume of the combustion air alone, if working at a high air-to-fuel ratio, which is necessary for good thermal efficiency, was too small to bring the combustion temperature down sufficiently to insure perfect operation of the turbine with its nozzle and uncooled turbine wheel with its delicate blading. More air required more work in compression eventually causing the efficiency of the whole unit to drop.

The unsatisfactory results of this test apparatus of 1905 have not been wholly overcome up to today, mainly due to the physical limitations of the materials which can only stand a maximum temperature of some 1100 to 1300 F for a long and continuous run. Furthermore, the price of such materials is prohibitive. The improvement of heat-resisting materials is, therefore, a very important antecedent to the future possibilities of an economical gas turbine which would be, no doubt, a very simple machine. But, it should be always kept in mind that the fuel ratio of about one and one half, compared to the theoretically possible one, produces combustion temperatures of some 1500 C or about 2750 F.

This interesting research work led me to the first of my ideas which I have followed quite successfully to the point of using exhaust gases from a piston engine to drive a turbine. By the initial expansion in the engine of the gases, the temperatures of the gases are brought down to a reasonable and manageable figure. Eventually, in 1905, this turbine was used to drive a precompressor for the charging of an internal-combustion engine so that it could be filled with denser air.

EARLY SULZER EXPERIMENTS

After having ceased all Diesel development work with the rather unsuccessful test engine in 1897 and 1898, the firm of Sulzer Brothers again stepped into the field. Its chief engineer came to Carels Brothers in Ghent, Belgium, and through an arrangement obtained the designs of the Carels' Diesel engine. In 1905 the latter firm had already built a three-cylinder engine of 500 bhp output, at that time the largest Diesel unit ever built. It was exhibited at the World's Fair, Liège, the same year.

With the entry of Sulzer into Diesel-engine building, a period of very strong and relatively rapid development began. Besides the four-cycle Diesel engine for stationary work, Sulzer developed a two-cycle engine for marine purposes, in which the scavenging air entered through ports around the whole circumference of the lower part of the cylinder liner and passed on a short path through the cylinder in one direction. The exhaust gases escaped through valves in the cylinder head. These engines, some of which were used for marine propulsion, were of the directly reversible type. Reversal was accomplished by means of a mechanism which shifted the control gear of the starting air, the fuel valve, and the exhaust valves to the correct timing positions for ahead or astern running of the engine.

It is a fact that several large firms have now come back to this original Sulzer design—Burmeister and Wain, Harland Wolff, and, in this country, the General Motors Corporation.

In a two-cycle engine, the inside wall temperatures of the piston, the cylinder liner, and the cylinder head, are much hotter than in a four-cycle engine of the same cylinder size. This is due to the fact that about twice as much fuel is burned in the combustion chamber of a two-cycle engine as in a four-cycle engine of the same cylinder volume.

In the original design, Sulzer encountered many difficulties, especially with the cylinder head, because of the many exhaust valves contained in it and the eventual cracking. The engineers decided, therefore, to discontinue this design and to develop the nonvalve two-cycle type. In this type, which, in principle, is still being built by Sulzer and in this country by the Busch-Sulzer Diesel Engine Company and lately by the American Locomotive Company, the exhaust gases leave the cylinder through ports in its lower part, but these extend only over one half of its circumference. On the other half of the circumference, two rows of scavenging ports are arranged. The upper row is separated from the lower row by nonreturn valves. These are arranged so that when the exhaust stroke starts, the exhaust gases are prevented from rushing out through the upper inlet slots into the scavenging-air manifold. The nonreturn valves between the two series of slots open only after the pressure in the cylinder has dropped below the scavenging pressure. This occurs at about 10 per cent of the piston stroke before its bottom dead-center position is reached. The Sulzer

arrangement has the further advantage that, because of the relatively high position of the scavenging slots, a good scavenging, and especially charging, of the cylinder is possible.

The Sulzer two-cycle engine is so well known that I do not need to talk to you about it further, but I would like to mention that in developing this engine, a very thorough investigation was made on wooden models to check and improve the scavenging and charging effect. The direction of the gas and air flow was checked by little fans, the movement in the air stream was observed through glasses which enclosed the model, and the air pressure was measured with piezometers. The results of these tests have, however, never been published.

DR. RUDOLF DIESEL

Now I want to say a few words about Dr. Diesel and his work. I saw him for the first time when I was standing, as a young fellow, at the brake of the first Sulzer test engine in 1898. As a youngster, I wondered how this famous inventor would look and what he would say. He was a very handsome and well-dressed man. Because the results were not so hopeful concerning the success of his engine, he was talking very seriously to Dr. I. Sulzer-Imhoof, who was responsible for the entrance into the Diesel-engine work of the Sulzer company. The prospects of this engine did not then look very bright, especially to the steam engineers. They could not believe in the Diesel engine's advantages and its practical possibilities.

Dr. Diesel obtained his principal patents in 1892. Five years elapsed before an engine was running more or less successfully at the works of the M.A.N., Augsburg. The first engine sold was installed near Frankfort in Germany. According to Dr. Imanuel Lauster, several changes and adjustments had to be made, but most of the troubles and stoppages were due to the inexperience of the operator. A high-pressure internal-combustion engine with maximum pressures of 600 to 700 psi was a much-feared machine. Also, its starting in the early days was not very quiet and smooth, reminding one of the firing of a machine gun, when compared with the silent and smooth-running steam engines working at pressures of 100 to 150 psi in those days. Consequently, psychological influences played a big rôle and, in a large measure, were responsible for the slow development of the Diesel engine, together with the steam-engine and steam-boiler competition.

Dr. Lauster was the one who performed most of the early and later research on the Diesel engine and put Dr. Diesel's theoretical ideas into practical and feasible shape. I am, therefore, pleased to mention his name on this occasion. His name should be written in gold letters in every book which deals with the development of the Diesel engine.

I met Dr. Diesel later many times when I was with Carels Brothers. About 1902, he visited us with Colonel Meyer, first promoter of the Diesel engine in the United States. In 1907 and 1908 all the principal Diesel patents had expired, but Dr. Diesel continued his development work. Together with a company in Switzerland, he organized the Safir Company in Zurich for the manufacture of small high-speed Diesel engines. The output of the engine, which was built, was 5 bhp per cylinder and the speed 600 rpm, which was at that time quite remarkable. Some engines were sold, mostly as auxiliaries, but were not a success. The little high-pressure air-injection pump caused most of the troubles, and Dr. Diesel lost a good deal of his fortune in this unfortunate undertaking, as well as in others.

Dr. Diesel also worked with the Sulzer Company, where I was at that time chief engineer of its research department, on some new proposals for Diesel-engined locomotives.

(*a*) The first idea suggested by Dr. Diesel was to have a Diesel engine coupled directly to the locomotive wheels and a large independent auxiliary compressor unit, consisting of a Diesel engine and a compressor, to supply starting air so that the locomotive could be started without combustion in the main cylinders or run by compressed air at very low speeds. A 1000-bhp passenger locomotive was actually built in 1913 for the Prussian Railway Company and run under its own power from Switzerland to Germany just before the beginning of the World War. It was put into service, but the outbreak of the World War stopped further tests and it was laid up in a locomotive depot where it rusted and had to be scrapped.[1]

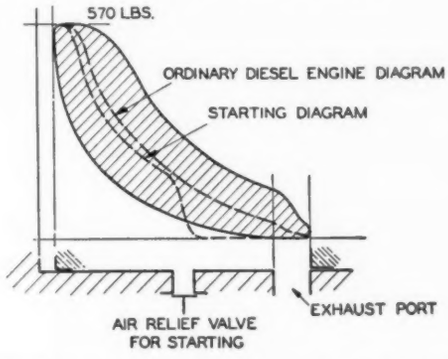

FIG. 4 DIESEL-KLOSE COMPRESSED-AIR AND INTERNAL-COMBUSTION LOCOMOTIVE ENGINE, 1909

(*b*) A second design by Dr. Diesel and his friend, Mr. Klose, was a two-cycle locomotive engine which had no scavenging but only exhaust ports. After almost all of the burned gas was exhausted from the cylinder, the remaining exhaust gas was again compressed to about 570 lb. Then air, compressed in an auxiliary compressor to the same pressure, was, at the top dead-center position of the piston, admitted into the Diesel engine together with the fuel. In this way, more air could be introduced into the engine cylinder than was possible with a standard Diesel engine. High outputs and bmep values of 300 and more pounds were possible. See Fig. 4.

However, upon trying to start this engine, unforeseen difficulties were encountered because the main engine had no scavenging means. When the engine was started by compressed air, the air, during admission into the cylinder, cooled down to a temperature very much below zero and, during the compression stroke, its temperature failed to rise to the ignition temperature of the fuel. To overcome this difficulty, a rather ingenious means was used which consisted of an air relief valve which opened from the atmosphere into the cylinder chamber. During the expansion of the starting air, when the piston reached the port of the relief valve, the starting air was exhausted into the atmosphere and during the remaining piston stroke atmosphere air was sucked in. This air of relatively higher temperature than that of the starting air at this part of the stroke increased the temperature so that during the compression stroke the ignition temperature was safely reached and starting with fuel was made possible.

FURTHER EXPERIMENTS

Further investigation showed that the compression of the air, in a separately driven compressor outside of the combustion cylinder, to the rather high combustion pressure required would cost too much in terms of energy, involve too much machinery, namely, a big Diesel auxiliary unit, and would result in a very high fuel consumption per brake horsepower. This idea was finally given up about 1911.

At about this same time, a personal hope which I long had

[1] An article on a recently built direct-drive Diesel locomotive was published in MECHANICAL ENGINEERING for May, 1938, p. 419.—EDITOR.

held was fulfilled. The Sulzer Company constructed a test plant where the combined operation of an exhaust-gas turbine, a Diesel engine, and a precompressor to charge the Diesel could be tested. These tests were carried out on a very wide range of different supercharging pressures, running from 0 up to 30 lb. We also ran tests at pressures as high as 1450 psi, and exhaust-gas turbine temperatures higher than 1200 F. These initial tests proved that such an exhaust-gas turbine would work because the temperatures were not too high and no corrosion or erosion took place on the blading of the turbine. Furthermore, the turbine did not choke up with the exhaust gases, even when they were smoky. Nevertheless, my company refused to continue the tests on a larger turbine because it was regarded as only a novelty.

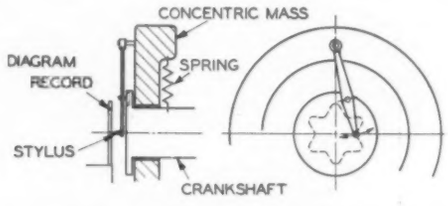

FIG. 5 TORSIONAL-VIBRATION MEASURING INSTRUMENT

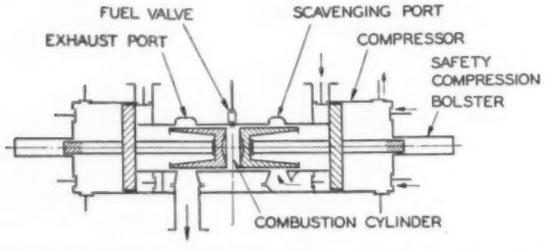

FIG. 6 PESCARA CRANKLESS FLOATING-PISTON ENGINE AND COMPRESSOR, 1932

Before the War there was a strong tendency to use very heavy oil fuels, such as tar oils, and, during the War, even tars in the Diesel engines. So that this could be done, special ignition oil was injected into the cylinders and, in many cases, the engine manufacturer had to furnish a distillating plant so that tar could be used. Now, the tars are used for armament purposes, the residues for the roads, and nothing is left for Diesel engines.

An interesting test engine was a 2000-bhp, single-cylinder engine built by Sulzer about 1912. The engine proved a success at once. Some trouble was experienced with the pistons and the lubrication of the piston bearings. Through tests it was found that even on the hot side of the water-cooled piston crown, temperatures as high as 1180 F were present. Because the walls had to be made very thick, the heat transmission, as calculations showed at once, caused this high temperature. The trouble with the piston bearings was overcome by introducing the lubricating oil at a pressure of over 400 psi. The diameter of the engine cylinder was one meter, or about 40 in. Commercial engines of such a cylinder size have not been built up to the present time.

In 1912, the research department of the Sulzer Company designed, built, and tested a horizontal single-cylinder engine with direct fuel injection without using any blast air. I believe this was the very first engine of this type. It ran successfully with Diesel oil, but when it was impossible to run the engine with tar oil, the company refused to have anything further to do with it.

Also in 1912, several 3600-bhp, two-cylinder stationary Diesel engines, which were built in the Sulzer plant, produced some very unexpected problems. While we were sitting in the drafting office one day, the whole building began to vibrate. Everybody became greatly excited, thinking it was an earthquake. A second series of shocks, but much weaker ones, followed. Shortly afterward, the test engineer of the first of these new Diesel engines came to the office and told us that the vibrations were produced when the engine reached its normal speed. We had for the first time reached the critical speed produced through the resonance of harmonic actions of the rotating and oscillating masses coupled to the crankshaft and the power impulses of the working process in the different cylinders.

We immediately built an instrument so that the movement of the crankshaft at the end opposite the flywheel could be measured. As shown in Fig. 5, a heavy concentric mass was arranged on the crankshaft and driven through relatively weak springs. On account of its heavy weight, this little flywheel ran at a constant speed. A lever with fixed points on the outer circumference of the crankshaft and on this flywheel gave us the information about the harmonic torsional vibrations of the crankshaft in the form of a six-pointed figure, which showed that the vibrations were of the sixth order per engine revolution. With this instrument it was also possible to measure the extent of each point during one revolution of the engine crankshaft. It was interesting to measure from the flywheel on the circumference of the crankshaft, which had a total length of about 15 yards and a diameter of 16 in., a movement of more than one inch, a movement that occurred six times during one revolution.

Further developments of any importance were stopped during the World War because every manufacturer had to furnish as many Diesel engines as he could. There was no need, no time, no money to spend on improvement of the Diesel engine.

I have now told my experiences in the development of the Diesel engine up to the time of the World War. Space does not permit me to mention in detail the further and greater development after this period. Direct injection of the fuel was finally introduced, followed by the creation of a semi-Diesel engine with lower compression and a type of red-hot cylinder-head arrangement as used for ignition purposes in the Bolinder, Brons, etc., engines; the latter idea has now been dropped. Then came the introduction of the precombustion-chamber engine, which is now being manufactured in plants located in this very city—so that I am safe in saying that among the members of the Central Illinois Section, there must be colleagues of mine who could give many interesting and important facts on this type of engine which is again being manufactured by many European manufacturers on a big scale on account of its pronounced advantages as to the quality of the fuel, the low pressures needed for injection of the fuel, and the rather smooth combustion which provides reasonable pressures on the piston and main bearings, especially important with high-speed engines.

For big outputs, principally for marine purposes, double-acting engines, first of the four-cycle and later of the two-cycle type, have been built, with the latter type still being manufactured.

FLOATING-PISTON ENGINE

Before I close, I would like to cite as a curiosity, the floating-piston type of Diesel engine. The idea of such a type without any crankshaft is an old one and we had already investigated it as far back as 1911 when I was with Sulzer. Lately, a method has been found to prevent the pistons from going out on both sides of the engines. This design was suggested by Pescara, as shown in Fig. 6, and by Junkers. The Swiss Locomotive Works, as well as other European concerns, has manufactured quite a number of these crankless compressor-type units.

Latest Developments of the BENSON BOILER

I—Review of Early Problems

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THE AUTHOR makes no pretense of being an authority on the design and operation of modern boilers. This paper treats the subject more from the standpoint of the designer of steam turbines. The subject matter is largely a communication from Germany on the latest developments and applications of the Benson boiler.

Before introducing the communicated matter, the author would like first to refer to earlier considerations on this important subject, review briefly the employment of higher pressures in this country, and point out reasons that led certain engineers of the Westinghouse Company to recommend to that company the desirability of its acquiring a license for the construction and sale of Benson boilers.

Many years ago, engineers occupied in the design of steam turbines recognized the gains in efficiency that were to be obtained by employing higher steam pressures. In those days, however, the price of boilers increased so much that the improved efficiency could not be justified.

Installations made during the early twenties, employing pressures as high as 600 lb per sq in. at a temperature of 750 F—then believed to be a maximum safe temperature—employed reheating to reduce the moisture content in the steam in the lower ranges of steam expansion. Reheating was found objectionable because of large pipes to and from the engine and boiler room, and also because of the necessity of somewhat complex regulating apparatus on the low-pressure turbine element to prevent overspeeding on loss of load because of the steam enclosed within the reheater and connecting piping. These reasons led engineers in this country to strive for higher steam temperatures employing as high pressures as may be consistent with reasonable moisture content in the exhaust steam; until now temperatures as high as 950 F are being employed and 1000 F offered. Concurrently with this, means more or less successful were devised in connection with the low-pressure turbine elements for draining away at least some of the moisture as it is precipitated during steam expansion. From the turbine designer's standpoint, or at least in the author's opinion, it would seem that further increases of pressure combined with lower operating temperatures and reheating is a lesser evil. The reduced available work because of operation with a lower initial temperature can be more than made up with an appropriate application of reheating.

A boiler was built by the English Electric Co., of Rugby, England, to the account of Mark Benson in 1923. Following some trials and for some time thereafter, all further development was undertaken by Siemens-Schuckert Werke in Berlin.

During the succeeding years the author had several opportunities for discussion with Siemens-Schuckert Werke in Berlin and made studies of the influence of the Benson boiler on power-station economics; and it seemed, following the working up of turbine designs, that great gains could be obtained by its means and by operation at critical pressure or higher. It should be understood that during these times it was supposed that a "once through" boiler, comprising a tube system in which feedwater was admitted to one end and superheated steam discharged from the other, must, in order to operate with stability, operate at least with critical pressure. In practice, steam at the critical pressure was throttled to some lower pressure, 1500 to 2500 lb per sq in., or some pressure suitable for the prime mover, and then superheated before use.

The studies made by the author led the Westinghouse Company to look further into the merits of the Benson boiler; a report of engineers who then spent some time in examination in Germany resulted in the company's acquiring an exclusive license in 1933. At this time it was learned that it had been shown that it was not imperative that this type of boiler be operated at the critical pressure, it could be operated at any pressure above, say, 500 lb per sq in., which resulted in the development in Germany of a system of operation with pressure varying in response to load demand.

The Westinghouse engineers recognized that this type of boiler offered reduction of cost at least in the moderately higher ranges of pressure because of the absence of drums and that it could operate at higher pressures than could boilers that are dependent upon circulation, the result of convection currents, and upon the steam's separating from the water within drums and the like. It presented an element of safety, because in case of any rupture, the result of pressure or temperature could cause little injury beyond interruption of service. It offered no gain in boiler efficiency, for obviously, any type of boiler can be as efficient as another if combustion is correspondingly complete and flue-gas temperatures are correspondingly reduced by heat-absorbing boiler surfaces. The important point seemed to be what could be accomplished in power-station economics by a unit comprising this type of boiler operating with extremes of pressure and a turbine system with reheating and regenerative methods of heating feedwater.

The principle of operating with variable pressure presented a simplification of the turbine inasmuch as, except for an emergency governor to prevent overspeeding, there is no need of valve gear controlling steam flow at the inlet to the turbine, although means responsive to the speed of the turbine may be employed for controlling feedwater supply and elements of combustion. The somewhat complex and costly means of automatic nozzle control whereby nozzle groups come in and out of action according to load variations, thus rendering the maximum available work at fractional loads, become no longer necessary. This principle permits the turbine to sustain enormous overloads without the addition of any special valve gear or by-passing means. It was significant that when operating with variable pressure and with proper allowance for vacuum

Contributed by the Power Division and presented before the Metropolitan Section of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, New York, N. Y., Oct. 19, 1938.

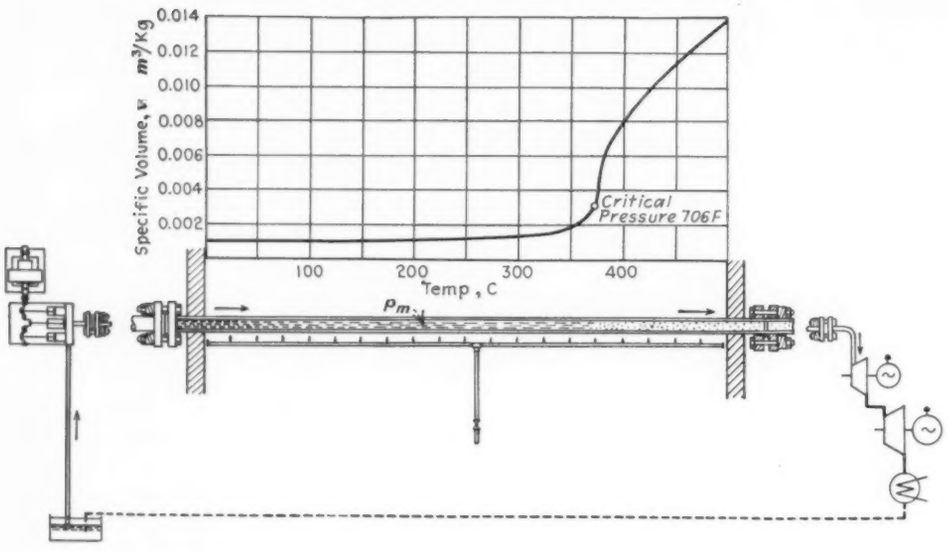

FIG. 1 SCHEMATIC DIAGRAM OF A SIMPLE BENSON BOILER FOR OPERATION AT THE CRITICAL POINT

(The curve shows volume plotted against temperature.)

variation with load, the isentropic heat drop to condenser pressure remains approximately constant down to low fractions of output; also, the total steam volume remains constant so that except for the lowest-pressure turbine elements the turbine proportions are appropriate for any internal output, and the turbine steam path therefore has a nearly constant efficiency. These points are discussed later.

It seemed that the exploitation could be best accomplished by the most intimate collaboration between the boiler and turbine-apparatus designers, rather than by a boiler manufacturer alone. The Westinghouse Company made several tentative proposals; in certain cases detail designs and cost estimates were made for a complete superposed plant, which showed complete justification for the investment. The Benson system appeared to be the next rational step in power-station economics.

That the company, for good reasons satisfactory to itself, decided, at least temporarily, to abandon development, is beside the point as to the value of the German development.

The German communication states that the Benson boiler has been developed by the Siemens-Schuckert Werke in Germany in recent years in a way that should prove interesting for American engineers.

The Benson boiler is a boiler with forced water circulation and was developed originally for operation at the critical temperature (706 F) which corresponds to a vapor pressure of 3200 lb per sq in. In its simplest form, as shown in Fig. 1, the Benson boiler consists of a heated tube through which water is forced and evaporated and superheated during this process. It had been the idea of Mark Benson, the inventor, to produce steam without any sudden increase of the volume and without ebullition and thereby to do away with the boiler drums which in normal boiler installations serve to separate steam and water. Experience with the first few installations showed that the Benson boiler is not limited to operation at the critical pressure, but can be operated at any desired pressure.

In the first large installations of the Siemens-Schuckert Cable Works in Berlin-Siemensstadt, the Langerbruegge Works of the Centrales Électriques des Flandres et du Brabant in Belgium, and the steamer *Uckermark*, the following unforeseen difficulties were encountered. As is well known, all feedwater contains varying amounts of salts which, in the case of normal drum-type boilers, accumulate in the water contents of the drums and are removed by continuous or periodical "blowdown" or rendered innocuous by the introduction of soda compounds. In the Benson boiler, these salts are deposited on the tube walls when the steam and water mixture changes to dry, saturated steam. In such a way a locally limited layer of salts is formed inside the tubes. This layer has the same heat-insulating effect as scale. In the first installations in Berlin and Langerbruegge, the zone of salt deposits was in the radiant-heat-absorbing tubes, i.e., those tubes exposed to the most intense heat.

As a consequence, the tubes became overheated, and some of them burst after being in operation for a few days. The cause of the failure of tubes, which also had occurred in some smaller and earlier boilers, was at first obscure, because when a tube that had failed was removed, it was found free from any salt or scale deposit. The substitution of more heat-resisting material resulted in no remedy. The fact was that a deposition of salts reduced the heat-transfer rate sufficiently for the metal of the tube to become overheated and that the salts went back into solution when water was circulated during the process of taking the boiler out of service. After recognizing the real cause, that part of the heating surface, in which salts had been deposited, was relocated to zones of lower flue-gas temperatures, so that an appreciable layer of salts did not result in any dangerous increase in the temperature of the tube walls.

The improved arrangement of the heating surface resulting from the experiences mentioned in the foregoing is shown schematically in Fig. 2. The boilers at Langerbruegge, in the S.S.W. Cable Works, and on the steamer *Uckermark* were reconstructed in this way. Fig. 3 shows the Langerbruegge boiler

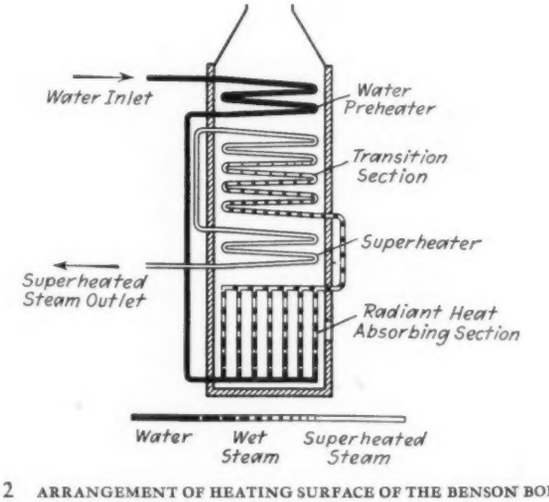

FIG. 2 ARRANGEMENT OF HEATING SURFACE OF THE BENSON BOILER WITH TRANSITION SECTION

after reconstruction. The reconstructed plants have now been in satisfactory continuous operation for six years. Salt deposits are flushed out periodically. For this purpose, the boiler is shut down for a short period, and water is pumped through the tube system for about one hour with a flow corresponding to about one third of the normal boiler rating. The frequency of this flushing depends on the condition of the feedwater. In plants using condensate for the feedwater, and where distillate is used also for make-up water, the flushing need not be carried out more frequently than once in three months.

Fig. 4 shows the results of such a flushing process in the S.S.W. Cable Works. Each process of shutting down and starting a Benson boiler automatically flushes the boiler by the nature of the process. Upon starting, water is pumped through the boiler by way of a special starting pipe, which ends in a settling reservoir or also in the reservoir of a cooling tower. The fire is ignited, the water first becomes heated, then changes to a steam and water mixture, and finally leaves the boiler in the form of superheated steam, whereupon the starting pipe is closed and the boiler is connected to the high-pressure steam system. This process is reversed when the boiler is to be shut down. Then the boiler is slowed down to the smallest possible load; the starting pipe is opened and at the same time the boiler is disconnected from the steam system; the fire is reduced until it is extinguished; and then water is circulated by means of the feed pump until clean water leaves the boiler. During this process, salts deposited in the boiler return into solution as already stated. Starting up the next time will then entirely remove any salts that remain. While it is possible to provide for an arrangement to permit flushing of sections of the boiler during operation, this has not yet been found necessary in Germany, since in 90 per cent of all cases it is always possible to shut down the boiler temporarily for flushing; furthermore, boilers are usually taken out of service for other operating reasons at more frequent intervals than once in every three months of continuous operation.

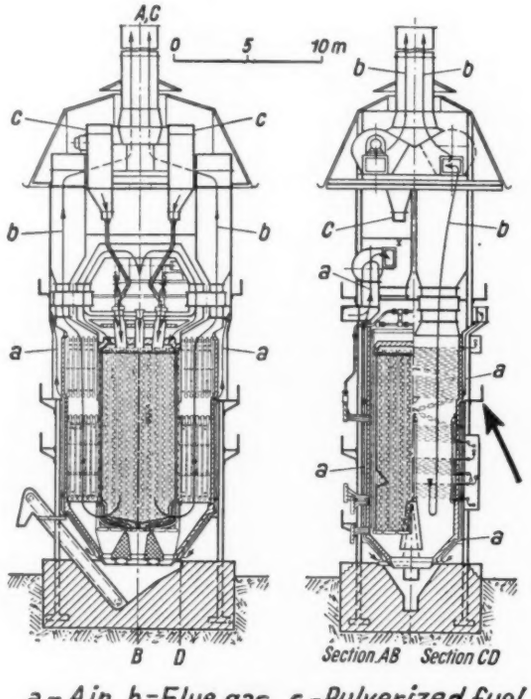

FIG. 3 BENSON BOILER AT LANGERBRUEGGE (BELGIUM), GENERATING 220,000 LB OF STEAM PER HOUR
(Zone of salt deposits is indicated by the arrow.)

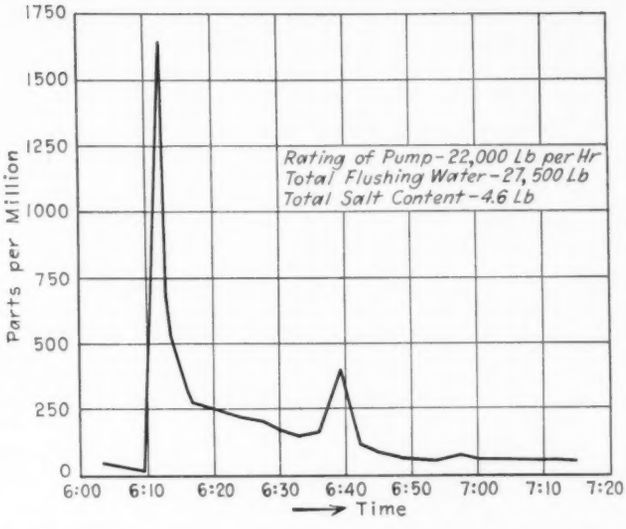

FIG. 4 SALT CONTENT OF FLUSHING WATER OF BENSON BOILER IN S.S.W. CABLE WORKS
(Most of the salt deposits are removed during the first minute. The second peak in the curve is caused by temporarily shutting down the pump to save water.)

It has been recognized in Germany that only condensate should be fed to high-pressure boilers of any type or system, including normal drum-type boilers, since otherwise salt deposits in the machines connected to the boilers are unavoidable. In plants where large amounts of steam are used for heating and industrial purposes, and where the condensate is impure, or much of it is lost, the German practice employs heat exchangers in which steam from the high-pressure turbine system is condensed, the evaporated steam going to a heating system. This practice is also employed in the United States when condensate from a heating system is either not returned, or, if returned, is contaminated.

With the advent of steam pressures of 1200 lb per sq in. and higher, difficulties have been experienced with drum-type boilers because of salts being carried into the turbine and choking the blade passages, the salts being carried over by moisture particles. The separation of steam from water is more difficult the higher the pressure; it depends upon the relative density of steam to water and the amount of relieving surface of the water. This difficulty has been greatly ameliorated by the adoption of various means of washing the steam with fresh feedwater before it leaves the drum. Similar difficulties have been occasionally experienced with Benson boilers, but, it is stated, only when because of some inadvertence, raw water has leaked into the system.

The salts present in a Benson boiler during the last fraction of evaporation have a degree of adhesiveness while the crystals are being formed and attach themselves to the tube walls. There are, however, certain kinds of salts that do not possess any adhesive properties, but it is stated that they generally deposit themselves with the adhesive salts and so may be readily flushed away. In the event of deposition of any insoluble salts, they may be removed by flushing with a weak solution of hydrochloric acid without injury to the heating surface. The original S.S.W. Cable Works boiler and the Langerbruegge boiler have each been once so treated during their lifetime of some six years. It is stated that the turbines of the Langerbruegge installation have never experienced any choking of turbine passages.

It would seem to be a point that in the Benson boiler the evaporation is of freshly admitted feedwater and that a large

portion of the liberated steam does not bubble through water in a drum in which the water may have a high salt concentration. Dr. Michel, of the Hamburg-American Line, who has had ships equipped with Benson boilers under his charge, states that "the Benson boiler carries over less salts to the turbine than are fed into it since there are deposits in the tubes and, even at the highest ratings, there is no priming and foaming. The amount of salt carried over as a function of the salt concentration in the feedwater is shown in Fig. 5 (curve *b*). It should be noted that even with a 1000 ppm feedwater only about 17 ppm are carried over. Curve *a*, Fig. 5, refers to a 25-ppm feedwater and shows the salt concentration of the superheated steam as a function of the pressure over a very large range. At 1000 lb

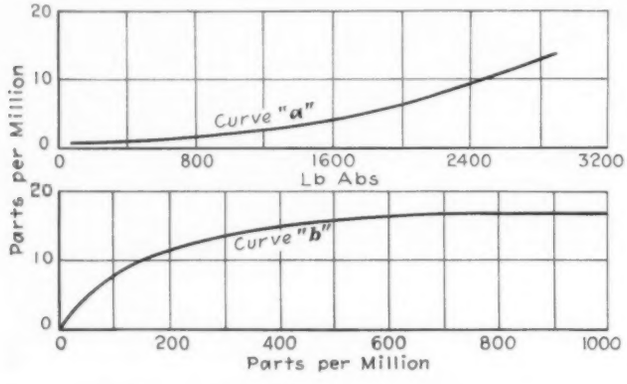

FIG. 5 SALT CONTENTS OF SUPERHEATED STEAM

(Curve *a*, as a function of the operating pressure at 25 ppm feedwater concentration and 800 F. Curve *b*, as a function of the feedwater concentration at 1400 lb and 800 F.)

per sq in., for instance, less than 2 ppm are carried over but for any type of boiler the quantity of salts carried over is not as important as whether they are of the kind that will stick to the turbine blades.[1]

Considerable improvements have also been made in the Benson boiler control. While a change of heating or of the volume of feedwater of drum-type boilers affects primarily only the quantity of steam produced, the steam temperature will be what may be according to the disposition and amount of the surface of the superheater. Of course, various means such as by-passing superheating elements are employed for the purpose of maintaining constant temperature. This requirement of maintaining constant temperature has become important with the advent of modern operating steam temperatures because a small increase above the designed temperature would become dangerous. In the case of the Benson boiler the difficulty of proportioning the superheater does not obtain. To express the difference in operation between the two types of boilers in homely language: With the drum type, one feeds fuel directly in response to pressure, and indirectly to load demand, and then feeds water in response to a level gage. With the Benson boiler, the process is somewhat reversed, one feeds water in response to load demand, and then fuel in response to a temperature indication. This comparison must not be taken too literally; obviously, both fuel and water should be simultaneously adjusted in response to load demand with a correcting impulse in response to temperature.

As will be explained later, there is a certain interval of time between the moment combustion is changed, as for example by changing the heat value of the fuel, and the moment the effect on the steam temperature becomes noticeable. A change in the firing of a Benson boiler can have its full effect on the steam temperature only after the feedwater has gone through the entire boiler, which takes one and one half to several minutes, depending on the load. An additional delay is caused by the heat inertia of the mass of metal of the superheater. It is obvious that under such conditions boiler operation is difficult, since temperature-controlled regulation will necessarily lag and result in overregulation. This difficulty has been remedied by the use of an auxiliary heating surface, as shown in Fig. 6, which consists of a thin tube of $^{10}/_{16}$ mm (0.39/0.63 in.) diameter, connected in parallel with the main heating surface or part of it. The auxiliary heating surface amounts to only a very small fraction (about $^{1}/_{1000}$) of the total heating surface. Water at high velocity is forced through the auxiliary tube, in which it is not evaporated, but only heated. The water passing through the auxiliary tube being proportional to the total volume of water, its temperature rise is therefore a direct measure of the heating and temperature of the boiler. Since it takes only about ten seconds to pass through the auxiliary heating tube, changes in the firing become manifest before they can have any effect on the steam temperature. Therefore, if the heat supply is regulated in such a way that the heating of the auxiliary tube remains constant, then also the steam temperature of the boiler will be held constant. As shown in Fig. 6, a throttling device is built into the feedwater pipe line between

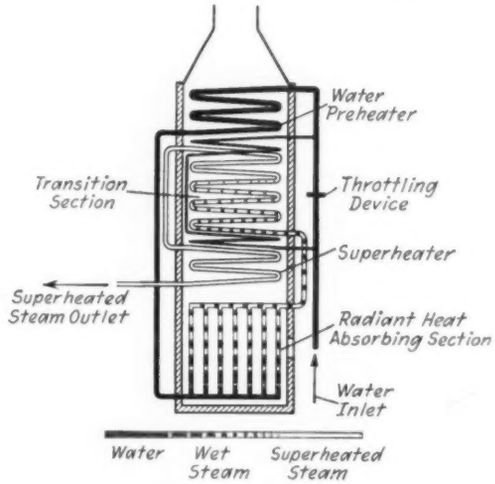

FIG. 6 BENSON BOILER WITH AUXILIARY HEATING SURFACE FOR CONTROL

the connections to and from the auxiliary heating tube, so that the desired water velocities will obtain. The auxiliary heating tube is now furnished with all Benson boilers and has operated satisfactorily in all installations thus equipped.

The regulation described in the foregoing applies only to corrections of undesired changes of firing or feedwater volume, and is, of course, merely a corrective supplement to the normal load-controlled regulation of feedwater, fuel supply, and air in their proper proportion. If fuel, air, and water supply are adjusted simultaneously, the desired increase or decrease in the steam production is obtained practically at the instant the increased or decreased fuel supply becomes effective in the combustion chamber, and delays in regulation are dependent solely upon the flexibility of firing.

Automatic control of a Benson boiler is not necessarily required, since half the boilers in operation are manually controlled. More than one system of automatic control is possible. One method of control has been developed and standardized by Siemens and Halske in which control impulses are obtained by Wheatstone bridges in combination with grid-controlled rectifier tubes. The resistance in one leg of the bridge

[1] See "Cause and Prevention of Turbine-Blade Deposits," by Frederick C. Straub, Trans. A.S.M.E., vol. 57, 1935, pp. 447–454.

changes in response to demand; that in another leg compensates by changing resistance in response to boiler operation.

Due to the economical conditions in Germany no new Benson boilers were installed between 1929 and 1933. In the years since 1933, however, the boiler industry experienced an exceptional upturn so today there are in operation or under construction no fewer than 82 Benson boilers, which may be classified as follows:

43 boilers, average rating 176,000 lb per hr each, for industrial plants with back-pressure or extraction-condensing operation

14 boilers, average rating 264,000 lb per hr each, for public-utility plants with condensing operation

6 boilers, average rating 26,000 lb per hr each, for universities, testing purposes, etc., intermittent operation

19 boilers, average rating 73,000 lb per hr each, for merchant-marine ships.

These boilers were manufactured by the following firms under license from Siemens-Schuckert Werke: Rheinmetall-Borsig, Berlin-Tegel; Duerrwerke, Ratingen-Ost; Walther & Cie., Koeln-Dellbrueck; Vereinigte Kesselwerke, Düsseldorf; Krupp Germaniawerft, Kiel-Gaarden; Werft Blohm & Voss, Hamburg.

Table 1 shows how Benson boilers have shared in the total high-pressure-boiler orders placed in Germany, for pressures of 1150 to 2150 lb, considering stationary boilers only.

Table 2 shows the installations in the German merchant marine. This excludes those boilers employed in naval service which cannot be referred to.

The materials employed for the tubing of Benson boilers are as shown in Table 3.

TABLE 1 SUMMARY OF HIGH-PRESSURE STATIONARY BOILER ORDERS PLACED IN GERMANY FOR PRESSURES OF 1150 TO 2150 LB

	Number		Rating	
	No.	Per cent	Tons per hr	Per cent
Stirling-type boiler	83	44.0	7515	48.7
Benson boiler	58	30.7	4850	31.5
Schmidt boiler	26	13.8	1537	10.0
Sulzer boiler	11	5.8	801	5.2
Sectional boiler	5	2.6	361	2.3
Loeffler boiler	5	2.6	255	1.7
La Mont boiler	1	0.5	90	0.6
Total	189	100.0	15409	100.0

TABLE 2 SUMMARY OF BENSON BOILERS INSTALLED ON GERMAN MERCHANT-MARINE SHIPS[a]

Name of ship	Year of construction	Nautical miles	Number of boilers	Pressure, lb per sq in.	Temp F	Rating each boiler, lb per hr
Uckermark	1928	496,800	1	710	800	53,000
Potsdam	1935	288,600	4	1,280	880	44000/55000
Pretoria	1936	132,000	2	1,140	840	62000/88000
Windhuk	1936	106,000	2	1,140	840	62000/88000

[a] The author has since been informed that the Hamburg-American line has under construction two 38,000-ton transatlantic liners to be propelled by the turbine-electric-drive system, each equipped with eight Benson boilers.

TABLE 3 MATERIAL USED IN BENSON BOILER TUBING

Steel	St 45.29	TH 30	CS 65
Analysis			
Carbon (C)	0.15	0.115	0.1
Sulphur (S)	0.004	0.008	....
Phosphorus (P)	0.005	0.016	....
Copper (Cu)	....	....	....
Manganese (Mn)	0.4	0.47	0.4
Silicon (Si)	....	0.11	1.2 to 1.5
Chromium (Cr)	....	....	2.5
Molybdenum (Mo)	....	0.38	0.4
Physical Characteristics			
Ultimate strength, lb per sq in.	64000 to 78000	54000 to 64000	64000 to 78000
Elongation in per cent	17	20	20
Yield point at 932 F, lb per sq in.	12,800	19900	34100
Creep limit at 932 F, lb per sq in.	4,260	12800	21300
Creep limit at 1112 F, lb per sq in.	0	2840	5300

Engineering Developments in the United States Merchant Marine

(Continued from page 208)

The guaranteed fuel consumption for all purposes is 0.43 lb of fuel oil per shp-hr based on fuel having a calorific value of 19,500 Btu per lb, but a much better result is expected on the trial runs.

In the other type of C-2 ships with the direct-connected opposed-piston type Diesel engines, the main propelling unit consists of a single four-cylinder two-cycle directly reversible engine with a bore of 32 in. and a combined stroke of 95 in. directly connected to the propeller shaft. The pistons and cylinders are cooled with fresh water. The guaranteed over-all fuel rate is the same as for the previously mentioned high-speed Diesel plant, but to compensate for its greater weight it is designed to operate on a somewhat lower grade of fuel oil. It might be mentioned that the cleaning of fuel oil by motor-driven centrifugal purifiers has been an important means of enabling Diesels of various types to successfully operate on some of the lower grades of fuel available today.

In addition to the ships under construction, the following is a list of ships for which, in the very near future, the Commission will receive bids:

1 Three combination passenger and cargo ships for the Mississippi Shipping Company will be driven through double-reduction gears by turbines of 7800 shp at 105 rpm with steam from three boilers at 450 psi gage pressure and 750 F at the superheater outlet.

2 The Commission intends to build a number of ships of its own design known as C-3, as illustrated in Fig. 4. These ships will consist of three classes, namely, turbine-propelled cargo ships, on which bids have been received; turbine-propelled combination passenger and cargo ships, shown in Fig. 5; and Diesel-propelled combination passenger and cargo ships, shown in Fig. 6. On the last two groups bids will soon be received. The number of ships to be built according to this C-3 design is undetermined at present but it is thought that a sufficient number of ships will be ordered from various shipyards to result in a diversification of power plants embodying the most recent engineering practices. The C-3 type steamships will be driven at a propeller speed of 85 rpm by double-reduction-geared turbines of 8500 shp, with steam supplied by two boilers at 450 psi gage pressure and 740 F at the superheater outlets. However, even those steam conditions are subject to variation. The Commission has asked for alternate bids for the installation of boilers providing steam at 600 psi gage pressure and 850 F at the superheater outlets, with machinery and equipment to match.

Designs are now being developed by the Maritime Commission covering the power plants of other cargo and passenger vessels, some in the larger class, which are expected to be at least the equal of any other vessels now in prospect.

Since the Commission's program covers tankers and refrigerated ships for which similar standards are being set, it can readily be seen that many novel and superior mechanical-engineering features will perforce be included.

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The photographs on these pages show some of the processes in making the resources of the Library available: . . . (1) The director confers with a bibliographer on problems presented in the incoming mail . . . (2) the classified catalog of the collection is consulted . . . (3) some questions require careful searching through all books relating to a subject. The Library's 150,000 volumes form one of the most comprehensive collections of engineering literature in the world. Approximately 6000 new publications are added annually. These are analyzed in detail by the Cataloging Department (4) and entered in the various catalogs of the library. More than 2000 periodicals, including society transactions, government bulletins, and research reports, are received currently, representing the most up-to-date engineering information being published in the United States and 39 foreign countries. The current numbers of these periodicals are kept in cases in the reading room (5) where they may be readily consulted by the public . . . The Search Department (6) carries out the actual work of locating desired information, compiling bibliographies, preparing annotations of the articles listed, when necessary, and translating foreign papers . . . The files of the Search Department contain four thousand bibliographies on special engineering subjects. Copies of these searches often furnish the answer to recurring problems or form the basis for further investigations. All the work of the Search Department is done to the exact specifications of the inquirer and is furnished at cost . . . The photostat machine (7) actually places the library's material at the disposal of the distant user who lacks adequate local facilities or cannot get to the Library in the Engineering Societies Building, 29 W. 39th St., New York City.

Because of its comprehensive resources, which include not only the most important current engineering publications but also many valuable works of historical importance in the development of the applied sciences, the Library, jointly maintained by and for the members of the American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers, and the American Institute of Electrical Engineers, is particularly fitted to render a valuable service to the engineering profession.

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A.S.M.E. HONORS AND AWARDS

V—Spirit of St. Louis Medal

A GREAT ACHIEVEMENT of far-reaching effect was the lone transatlantic flight of Charles A. Lindbergh in his airplane, the *Spirit of St. Louis*, an accomplishment due to the combination of physical perfection of man and machine. As a result of this flight, there was an immediate and tremendous increase of interest in aeronautics on the part of the public, providing a great impetus to the aeronautical industry.

Consequently, the airplane, *Spirit of St. Louis*, now reposing in the Smithsonian Institution in Washington, D. C., serves as a symbol for noteworthy achievement in American aeronautics. For this reason, when the St. Louis Section of The American Society of Mechanical Engineers decided to establish a medal to be awarded by the Society for meritorious service in the field of aeronautics, it was named after this worthy product of American aeronautical and mechanical engineers.

The Spirit of St. Louis Medal was made possible by an endowment of $3500, created in 1929 by the St. Louis Section through the generosity of Philip DeCatesby Ball, A.S.M.E. members, and citizens of St. Louis. The income from this sum provides a gold medal every three years for a recipient selected by the Committee on Medals of the Board of Honors and Awards, subject to the approval of the Council of the Society. The recipient must be an individual who has rendered some very exceptional service in the advancement of aeronautics.

DESCRIPTION OF MEDAL

The obverse side of the medal depicts the rearranged emblem of the Society, the globe and the lever, which is based on the declaration of Archimedes, "Give me a place to stand and a lever long enough and I will move the world," and the whole is representative of the power man can exert through mechanical aids, of which the lever is one of the fundamental representations. On a shield below is engraved the name of the recipient and the year in which he received it. Beneath the shield is the inscription, "For Meritorious Service in the Advancement of Aeronautics," followed by 1929 in Roman numerals to signify the year of the founding of the medal. Surrounding the whole is the name, "The American Society of Mechanical Engineers."

On the reverse side, Victor S. Holm, the sculptor, depicts Icarus as the figure typifying the Spirit of Flight. Icarus symbolizes the aspirations and possibilities of the genius of man. According to this Greek myth it was he, with wings of eagle's feathers made by Daedelus, who flew so high that the wax holding the feathers was melted by the heat of the sun causing the young man to fall into the sea and drown. It is symbolic of man's struggle with the elements and, though told thousands of years ago, anticipated man's ultimate victory in mechanical flight, following many failures and disasters, and after many "have fallen into the sea." Under the name of Icarus, which is in Greek, is found the year of the flight of Lindbergh in the *Spirit of St. Louis* to Paris—1927—a subtle and delicate compliment to man.

MEDALISTS

DANIEL GUGGENHEIM was the recipient of the first Spirit of St. Louis Medal in 1929 for his tremendously beneficial and unselfish contributions in the interest of aeronautics through the founding of the Daniel Guggenheim Fund for the promotion

The fifth of a series of articles, prepared under the direction of the Board of Honors and Awards of The American Society of Mechanical Engineers, better to acquaint the members of the Society concerning the honors and awards which are given in recognition of meritorious achievements of engineers.

DANIEL GUGGENHEIM

PAUL W. LITCHFIELD

WILL ROGERS

JAMES H. DOOLITTLE

Recipients of Spirit of St. Louis Medal

of Aeronautics that has served aviation in so many magnificent ways. The Daniel Guggenheim Medal, created for the purpose of honoring persons for notable achievements in the advancement of aeronautics, was made possible by the gift of an endowment from the Fund in 1928, and is awarded annually by a Board, composed of representatives of The American Society of Mechanical Engineers, the Society of Automotive Engineers, and the Institute of the Aeronautical Sciences. Another important contribution by the Fund was a grant of $1,200,000 to various engineering schools for the purpose of research and instruction in the science of aeronautics. It has given further assistance to the California Institute of Technology, Massachusetts Institute of Technology, Stanford University, University of Michigan, and University of Washington for wind tunnels and laboratory equipment.

PAUL W. LITCHFIELD, president of The Goodyear Tire and Rubber Co., was the recipient of the second Spirit of St. Louis Medal in 1932 for his meritorious service in the advancement of airship design and construction in the United States. Mr. Litchfield is widely known for his deep-seated interest and continuous activity in aeronautics, particularly in lighter-than-air craft. In 1911, under his direction, his company began designing and building free training balloons for the army and navy. During the World War it built more than 1000 free and observation balloons and close to 100 airships. Through his efforts in 1924, the Goodyear Zeppelin Corporation acquired the German Zeppelin patents for the construction of rigid airships in this country and erected the world's largest airship dock in which it built the *U.S.S. Akron*.

WILL ROGERS, the great American humorist, was the recipient of the third Spirit of St. Louis Medal for the splendid constructive and unselfish work he did in the advancement of aviation and the building up of public confidence in aviation through his articles in the press, over the radio, and from the speaker's platform. Ironically, the Board of Honors and Awards of the Society announced the award of the medal to him on Aug. 15, 1935, the day Will Rogers was killed in an airplane accident in Alaska. The award was presented posthumously in October to Mrs. Rogers, the widow.

JAMES H. DOOLITTLE, member A.S.M.E., was awarded the fourth Spirit of St. Louis Medal in 1938 for his notable contributions to the advancement of aeronautics. In 1922 he made the first nonstop flight across the United States, and in 1931 the first crossing of the continent in less than half a day. He has established world speed records with both seaplanes and land planes, demonstrated this country's planes in South America, Europe, and China, received the Distinguished Flying Cross for work done in testing the strength of airplanes under actual flight conditions, and also received special honors for experimental work in blind flying and for trans-Andean flights. Since 1930, when he resigned his commission as first lieutenant of the U. S. Army Air Corps, Major Doolittle has been director of aviation and research for the Shell Petroleum Corporation.

SPIRIT OF ST. LOUIS JUNIOR AWARD

DURING the 1938 Semi-Annual Meeting of The American Society of Mechanical Engineers in St. Louis, Mo., E. H. Sager, secretary of the St. Louis Section, handed to President Harvey N. Davis, representing the Society, a check for the balance in the fund, provided largely by St. Louis members, to finance the 1935 National Meeting of the Aeronautic Division in St. Louis. It was requested that the income derived from investment of this fund, supplemented by the necessary additional amount from the Spirit of St. Louis Medal fund, be used to provide a triennial cash award of $50 to be given for the best paper on an aeronautic subject by a Junior member of the Society. At the time of writing this brief article, the conditions of the proposed award had been referred by the Council to the Board of Honors and Awards for review and for report to the Council when final arrangements for the administration of the award are consumated.

The conditions which govern the proposed award are as follows:

(1) Competition shall be limited to Junior members of the Society, less than 30 years of age. (2) The Award shall be made every third year and names of winners shall be made known simultaneously and in conjunction with the announcement of names of recipients of the Spirit of St. Louis Medal. (3) The Award is to be made on the basis of the best paper on an aeronautical engineering subject presented at a Junior Group meeting during a three-year period prior to the giving of the Award and submitted to the Board of Honors and Awards within a reasonable period (to be determined by the Board) after its presentation. (4) To be eligible for this Award, papers must have only single authors. (5) Other conditions shall be left to the discretion of the Board of Honors and Awards.

TECHNOLOGY *and* PRICE-MAKING

By RALPH E. FREEMAN

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

THIS VOLUME[1] develops the thesis advanced in a previous Brookings study entitled, "Income and Economic Progress," to the effect that the surest way to attain and stabilize prosperity is by means of a gradual revamping of price policy so as to pass on the benefits of technological improvements to the general body of consumers. The present publication explains that under modern conditions the producers of industrial goods are not the helpless victims of market forces—as they are purported to be by some economists—but are rather in the position of price makers. While vigorously denying that the competitive system of free enterprise is obsolete, the authors point out that because of the differentiation of products through sales-promotion activities, the increased size of the business unit, and the group solidarity effected by trade associations and in other ways, the business leader is the initiator of many prices. The prices of most manufactured goods are born, not in the market, but in the industrial office.

This strategic position of the businessman in the economic process places upon him a heavy responsibility. He may adopt one of two methods of price-making. He may look at his product as a cumulation of cost items for materials, labor, machine service, and various overhead costs, which, when added together, with the inclusion of a proper loading for profit, gives him the price to be charged. This is mechanistic price-setting. According to this policy, when the profit margin is threatened, the producer restricts his output, thus curtailing employment and forcing consumers to forego commodities which might elevate their level of living.

The other alternative is dynamic price-setting. "It starts from the consumer's wants and purchasing power and courageously accepts the task of finding a means of satisfying these wants within the limits of this purchasing power." If this purchasing power is insufficient to absorb the whole output of the plant at the prevailing price, ways must be devised which will so economize costs that prices can be reduced and the output increased. It is not simply a matter of lowering the price so that a greater sales volume will compensate for a lower profit per unit. The price must be cut to a point where the sales equal the capacity of the plant. In fact, a dynamic price policy means more than this. It means price reduction to a level that will enable an increased plant capacity to be utilized. Profits are to be maintained partly from the economies of mass production following the enlargement of sales and partly from technical improvements—new machines, new methods, redesign of products, the utilization of less costly materials, and the like.

"If an executive is to make a real stride forward toward enlarged efficiency with a new technique whose success will depend on plant outlays which will produce minimum costs through mass production and follow a price policy which will secure mass buying at a stimulative price, he must not only conduct experiments in the chemical laboratory and provide for invention and building of equipment not known before; he must also conduct careful studies of the nature and elasticity of demand, prepare the field for his product, and systematically promote its introduction to and exploitation among consumers."

A considerable amount of space is devoted to the place of the large business unit in the economic system. It is pointed out that the small concern may be incapable of devising and carrying out the production strategy adapted to a dynamic price policy. "Daring, broad-scale innovations in the way of technique and price experimentation involve large forward commitments which often cannot be made by small business concerns, no one of which can control a volume of supply large enough to have a significant influence in the market. Thus the persistent dissolution of large corporations would bring us to the point where we had not the power to make industrial advances which would progressively lower prices. 'Pure competition' is not the path to economic progress in an industrial age."

There will be general agreement with the main thesis that price reduction is the best means of disseminating the benefits of technical progress and that these benefits can be disseminated effectively only if businessmen are courageous, imaginative, and forward-looking. But some of us may be less confident than the authors appear to be, in the ability of industrial engineers to supply the new techniques necessary to full utilization of all the plants which businessmen may see fit to construct. No matter how rapid the rate of technical change, errors of judgment, excess optimism, unforeseen changes in demand, and the fluctuations of the business cycle will probably make much unemployment of industrial plants unavoidable.

The conclusions of the authors are limited in significance because of two restrictions they have imposed upon themselves. The first is that the lowering of wages and raw-material costs as a means of price reduction is excluded from consideration. The burden of adjustment to lower prices is thus thrown entirely upon technological sources of economy. The second is that attention is directed to long-term trends rather than to cyclical movements of business. Yet in spite of this limitation, the reader gets the impression that price reduction provides an effective means of escaping the effects of a business depression, even in the absence of important technical advances.

The present book is to be welcomed because it emphasizes the importance of price derangement as a cause of our failure to utilize to the full the industrial plants that are available and the men and women who are willing and able to work. The prevalence of unutilized capacity in recent years has given birth to the notion that the production of goods and services has outrun the size of the population. The adherents of this theory attribute our economic woes to the fact that we have too many goods; that our power to consume the desirable things of life has not kept pace with our power to produce them.

Such emphasis upon lack of purchasing power is likely to be misleading. When the output of an industry is kept below the point at which its facilities are fully engaged, the reason is that the market will not absorb a greater volume at the price being charged. At a lower price capacity output would be obtainable. The authors of this book point out that in many cases this lower price may be a remunerative one. We should not conclude, however, that this solution is always available. Curtailment of production capacity may, in some instances, be the only proper remedy to apply, and such curtailment may involve delays and difficulties not easy to overcome.

[1] Industrial Price Policies and Economic Progress, by E. G. Nourse and H. B. Drury, Brookings Institution, Washington, D. C., 1938.

One of a series of reviews of current economic literature affecting engineering prepared by members of the department of economics and social science, Massachusetts Institute of Technology, at the request of the Management Division of The American Society of Mechanical Engineers. Opinions expressed are those of the reviewer.

BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context and credit to original sources is given.

Day by Day

ALWAYS conditioned by the fact that war in Europe would materially change the trend of the economic life of this country, opinion that the trend is slightly upward rather than downward finds support in views of commentators and in statistics. Evidence so far indicates that the Congress will exercise a greater independence of thought and action than it has shown in six years. But the President's budget message plainly showed continued reliance on the part of the Administration on the theory of spending for recovery. Although government spending is an undoubted stimulus to economic activity, there are many who question whether it can ever be more than that, for the expected improvement in private spending has failed so far to advance to a point where, under the spending theory, it will take up the burden it normally bears. Reasons for this are conveniently summed up in the phrase "lack of confidence," and the results are evident in subnormal expenditures for durable goods and private construction, two sources of economic health upon which engineers chiefly rely.

Perhaps one of the most encouraging events of recent weeks was the agreement reached between Mr. Wilkie and the TVA on the price to be paid for public-utility properties within the sphere of influence of the Authority. It is an amazing commentary on the relationship between government and private enterprise that the fact that the properties were not virtually confiscated was hailed with expressions of relief. To engineers there is satisfaction that the principles of Arthur Morgan in giving the utilities a fair deal won out and in the hope that there may be a revival of activity in the power industry which is said to be in a position to spend many millions of dollars.

Satisfaction is also expressed in comments by Senator O'Mahoney as a result of preliminary investigations of the Antimonopoly Committee of the patent situation. In a public statement the Senator summarized his views, briefly, to the effect that inventors and business apparently still need the protection and stimulation of patents; that the patent system has been of benefit; that proposed amendments would encourage competition; that changes suggested by Commissioner Coe are directed at the elimination of legalistic abuses; that there is a tendency toward group action, research laboratories having unquestionably greatly advanced the frontiers of scientific knowledge and incidentally procured for the corporations that operate them valuable patents without greatly restricting the individual inventor in the field of mechanical development; that the greatest handicap under the present system arises from the lack of a single court of patent appeals; that manufacturers as well as inventors seem to agree that patent procedure should be so changed that action on a patent application may not be unduly delayed in the Patent Office and that the entire life of a patent from date of application to date of expiration shall not be more than 20 years; that the fact that patents are the keystones in many important industries had been brought home to the Committee with great emphasis; and, finally, that there was practically unanimous agreement that Congress, by the enactment of the Patent Law, has given this country a system far superior to that which exists in any other country. Engineers generally will be relieved at the sympathetic view Senator O'Mahoney has expressed of the patent system as he has found it.

Electricals

During the closing week of January, 1939, The American Institute of Electrical Engineers captured the facilities of the Engineering Societies Building and put them to good use from Monday morning, January 23, to Thursday night, January 26, and provided, in addition, eight excursions for Friday. Six other inspection trips were made available on Tuesday and Wednesday. With 17 technical sessions, two general sessions, five conference sessions, and the usual allotment of committee meetings, time was found for a smoker, a dinner dance, and an evening of medal presentations.

It was the Electricals' year to sponsor the presentation of the John Fritz Medal, highest engineering honor awarded to engineers in this country, and this ceremony was combined with that of conferring the Edison Medal awarded by the Institute. The presentation ceremonies took place on Wednesday evening at a joint ceremony of the Institute and the John Fritz Medal Board of Award which is made up of 16 representatives of the four Founder Societies.

Presentation of the Edison Medal to Dugald C. Jackson was made by John C. Parker, president of the Institute.

In presenting Dugald C. Jackson for "the highest honor in the hands of our Institute to bestow—the Edison Medal," J. W. Barker, dean of engineering, Columbia University, member A.S.M.E., reviewed the career and principal achievements of the distinguished consulting engineer and educator. Of Dr. Jackson's abilities in consulting practice Dean Barker said: "Possessed of one of the most remarkable memories for all kinds of facts, with an uncanny ability to sort essentials from nonessentials, with a keen analytical ability to get to the heart of a problem, with great powers of concentration and the ability and willingness to work indefatigably, he could and did synthesize a clear, persuasive statement of even a most complex problem . . . . . so that his reasoning was followed and his conclusions accepted." Of Dr. Jackson's philosophy of education Dean Barker mentioned three basic objectives: First that students should be brought as soon as possible into contact with the unknown, thus stimulating them to think for themselves; second, a practical system of cooperative (part time in school, part in industry) engineering education; and third an "honors" system which sections all large classes into small groups based on equivalent mental speed of the students, culminating in one group known as the "Honors Group" who are relieved of all stated class meetings but are held responsible through a truly comprehensive examination.

W. H. Harrison, past-president of the Institute and member

of the John Fritz Medal Board of Award, conferred the John Fritz Medal on Frank B. Jewett, president of the Bell Telephone Laboratories, Inc., and vice-president of the American Telephone and Telegraph Company. Karl T. Compton, president of M.I.T., spoke of the medalist's career and achievements and characterized him as a "leader, statesman, and nobleman of science." The citation for the award read: "For vision and leadership in science and for notable achievement in the furtherance of industrial research and development in communication."

In his response Dr. Jewett paid tribute to the great number of his associates who, he said, rightly should share with him in any such honor as the John Fritz Medal. What degree of success he had attained had been the result of cooperative effort. He spoke with charming informality about important influences in his early career, and asserted that his life was essentially the antithesis of a planned career. He laid some claim to being a "drifter" and of taking up the things of the moment. He confessed that he had left his position at M.I.T. to take up work with the telephone company without much heavily considered appraisal of the consequences. The world of tomorrow, he stated in closing, would be much better than the world of today and would present much more of a challenge. However, he concluded, we have an "improved kit box of tools" with which to attack its problems.

Civils

Twenty-four hundred persons participated in the manifold program of the eighty-sixth annual meeting of the American Society of Civil Engineers that took over the Engineering Societies Building from Wednesday, January 18, to Saturday of the same week. Presentation of honorary memberships and prizes constituted the business of the opening session. Prof. C. Frank Allen, of M.I.T., Dean Anson Marston, The Iowa State College, Arthur S. Tuttle, consulting engineer of New York, Frank E. Weymouth, Metropolitan Water District of Southern California, and Edward E. Hall director of public utilities, St. Louis, Mo., were the recipients of honorary membership, and, with the exception of Mr. Hall, all were on hand for the occasion. Five prizes were awarded. In addition a past-president and honorary member of the Society, John F. Stevens, famed for engineering work on the Panama Canal and for Western railroads, and for humanitarian services in Siberia during the War, received the Hoover Medal. Unable to be present in person, Mr. Stevens was represented by his son, Donald F. Stevens, also a civil engineer. Gano Dunn presented the award and Ralph Budd eulogized the recipient. A replica of the certificate is reproduced on this page. Technical sessions, social gatherings in the form of a dinner and dance, a smoker, and luncheons, a conference of student chapters, inspection trips to Allentown, Pa., and about New York City, and "college reunions," in addition to business and committee meetings, provided entertainment and instruction.

One significant aspect of the work of the society along nontechnical lines was noted in the annual report of the Board of Direction. In a section devoted to "professional status" the report said:

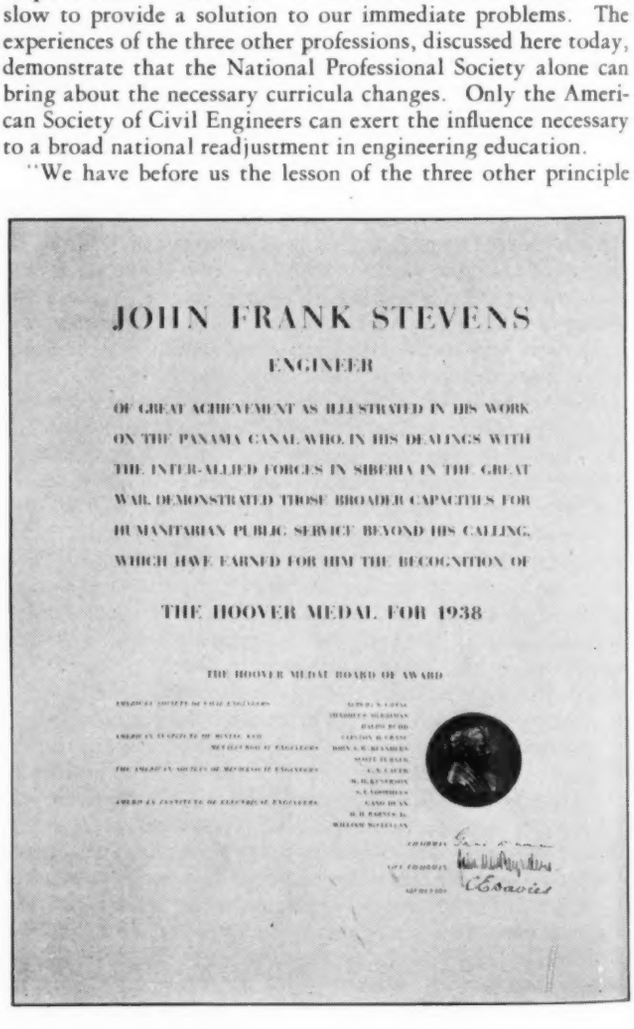
"Of all the Society's numerous working units, designed to improve the status of the engineer, the newly formed Committee on Professional Objectives has by far the broadest scope. Many functions have been assigned to this Committee, for study or for aggressive action, all leading steadily toward a greater recognition of the value of civil engineers to the community. Five cardinal objectives are: (1) To promote understanding among engineers, and between the profession and the public, in order to increase the usefulness of the profession to society; (2) in the interest of economy and public safety, to encourage and demand a wider use of trained engineering talent in the creation of all types of structures, especially in public works, thus increasing a public demand for engineers in planning, management, and administration; (3) to analyze the economic and social status of the engineer in the light of national trends, and to keep the Society's members alert to the implications of its continuous findings; (4) to establish a 'Clearing House' of ideas for members of the Society who are interested in the affairs and development of both salaried and employer engineers; and (5) to serve as an agency through which the Local Sections can readily exchange ideas as to the solution of any given problem in their allotted fields of endeavor.

"The Committee has other duties, in addition to which are the separate and coordinated functions of such units as the Committees on Public Information, Salaries, Fees, Registration, and Unionization of Engineers."

At the annual meeting in January this Committee on Professional Objectives, of which E. R. Needles is chairman, conducted a symposium on improvement of social, economic, and professional status of the civil-engineering profession. Speakers representing the architectural, legal, and medical professions spoke, as well as a number of members of the society. Representing the American Society of Civil Engineers on the program was Carlton S. Proctor, who referred to the establishment of a course in general engineering at Princeton. He said in part:

"A new departure such as this by an institution of the preeminence of Princeton will of course provide the desired leadership for others to follow, but such an evolution will be far too slow to provide a solution to our immediate problems. The experiences of the three other professions, discussed here today, demonstrate that the National Professional Society alone can bring about the necessary curricula changes. Only the American Society of Civil Engineers can exert the influence necessary to a broad national readjustment in engineering education.

"We have before us the lesson of the three other principle


JOHN FRANK STEVENS

ENGINEER

OF GREAT ACHIEVEMENT AS ILLUSTRATED IN HIS WORK ON THE PANAMA CANAL WHO IN HIS DEALINGS WITH THE INTER-ALLIED FORCES IN SIBERIA IN THE GREAT WAR DEMONSTRATED THOSE BROADER CAPACITIES FOR HUMANITARIAN PUBLIC SERVICE BEYOND HIS CALLING WHICH HAVE EARNED FOR HIM THE RECOGNITION OF

THE HOOVER MEDAL FOR 1938

THE HOOVER MEDAL BOARD OF AWARD

professions and the opportunity to see what stern self-disciplinary control of their professions has done for them; through requirement for post-graduate training their selection and accrediting of schools and teaching staffs and professional curricula and through their control of professional practice and activities.

"It requires plenty of determination and intestinal fortitude to challenge and ultimately control the institutions of professional education, to force the abolishment of competition for students between engineering schools; and to exercise a strict self-discipline of the profession. But the fruits of such efforts are the objectives which we seek. The moving finger writes—make our profession worthy of the desired 'status' and all these other things will be added unto us."

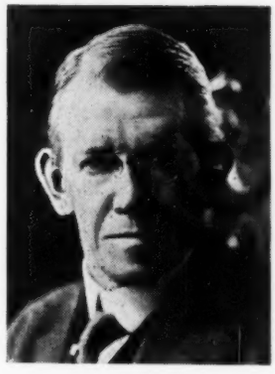
Newell Sanders

In an age that sets greater store by security than by progress, that ties its talent up in a napkin and buries it in the ground, and that complains because the frontier has disappeared, it is heartening to consider the life of Newell Sanders, member A.S.M.E., recently deceased at his home in Chattanooga, Tenn. Possessed of the homely virtues of thrift and energy, Mr. Sanders laid the foundation of a fortune and a useful life by improving one of man's oldest tools—the plow—and demonstrated that frontiers exist only in men's minds and not in their environments. Of a man who was able to convince farmers of the virtues of a new plow it cannot be said that he buried his talent. Nor could any one stand amid the blossoming trees around the Senator's house on top of Lookout Mountain and gaze down at the city below without admitting that whatever there was of peace about that home had come as a dividend of hard work and not because the worker had attained some legal majority of years that entitled him to ham and eggs every Thursday.

Newell Sanders' forebears had lived in North and South Carolina before and during the Revolution, and had migrated northward and westward through Tennessee and Kentucky into Indiana and Iowa, from whence John Sanders, Newell's father, returned to Indiana. Newell Sanders was graduated from Indiana State University in 1873, as was also his wife, and four years later the young couple moved to Chattanooga. Two years later Sanders made his first bid for election to public office, thus beginning a long career in local, state, and national politics. In 1911, Governor Hooper of Tennessee appointed him to fill the position made vacant in the United States Senate through the death of Robert L. Taylor. He was an ardent advocate of "prohibition" and of "woman suffrage" and a delegate to seven Republican national conventions.

Daniel W. Mead

Presentation of the Washington Award for 1939 to Daniel W. Mead "for his superior contribution to sound theory, good practice, and high ethical standards in the creation of engineering works," provided one more occasion for the engineering profession to honor an eminent teacher and consulting engineer. The nature of his work, hydraulic and sanitary engineering, has brought Dr. Mead most closely into contact with the American Society of Civil Engineers, which has recognized his attainments and services by electing him to honorary membership and to the presidency. Dr. Mead is also a member of a dozen or more other engineering societies, including the A.S.M.E. His engineering ability and judgment have brought him international reputation in assignments of world-wide interest: e.g., membership on the commission of the Red Cross and Chinese Republic for flood protection in 1914; consulting engineer of the Miami Conservancy District 1913 to 1920; membership on the Colorado River Board which passed on the Boulder Canyon Project; reporting to the Chief of Engineers, U. S. Army, on foundations for the dam at Muscle Shoals, and many others. Activated by a high sense of intellectual integrity and engineering ethics, he has spoken fearlessly on subjects on which his engineering knowledge and experiences have earned for him the position of an authority. In addition to books on water-power engineering and hydrology he has written for engineers or contracts and specifications and on other professional phases of the engineer's career, such as ethics. He belongs to that illustrious group of men of his age and profession who have combined theory, teaching, and practice with such balance and energy as to advance all three.



D. W. MEAD

Technical Public Works Committee

According to an announcement made late in January by the National Resources Committee, a Technical Public Works Committee has been appointed for the purpose of bringing together federal officials concerned with public works and citizens especially qualified to advise on the economics and timing of public construction activities. Says the announcement:

"Col. Henry M. Waite was named chairman of the committee and Frank W. Herring, of the American Public Works Association, vice-chairman. Other members are F. E. Schmitt, *Engineering News-Record;* Otto T. Mallery, member Pennsylvania State Planning Board; William Stanley Parker, Construction League of America; Frederick J. Lawton, Bureau of the Budget; Corrington Gill, Works Progress Administration; Fred Schnepfe, Public Works Administration; Lowell Chawner, Department of Commerce; A. F. Hinrichs, Department of Labor; and Lt.-Col. Paul W. Baade, War Department.

"This group has been asked to assist the National Resources Committee in continuing its preparation of 6-year programs of federal public works and in stimulating the preparation of such capital budget programs by states and cities. In addition the new committee will undertake studies to determine the most effective utilization of state and local public works for stabilizing the construction industry and to analyze the plan of public construction activities in providing employment and increasing the national income."

Airplane Piloting

In recognition of the development of the automatic pilot and direction finder for airplanes and other navigation instruments, the Sperry Gyroscope received the gold medal of The American Institute of the City of New York at its annual award dinner held early in February.

In connection with the award of the medal P. R. Bassett, vice-president in charge of engineering of the Sperry Gyroscope Company, Inc., spoke of the developments in applications of the gyroscope carried on by the late Elmer Sperry, past-presi-

dent of The American Society of Mechanical Engineers, and demonstrated the "Flightray" and the Sperry-RCA automatic direction finder.

The Flightray, he said, "consists of a cathode-ray tube which is electrically connected in rapid sequence to the necessary flight instruments. Each instrument in turn causes the cathode ray to flash its indications on the face of the cathode-ray tube. The sequence of indications is so fast, however, that the eye is unaware of the series but sees all of the indications simultaneously and without flicker. The pattern that the instrument traces on the cathode-ray tube is simple and easy to interpret. A novice can fly by means of its indications with less than an hour's training, and an experienced pilot can make excellent blind landings by its aid before the end of his first lesson. I venture to predict that it will not be long before it is common practice for transport pilots to bring their airplanes down by instruments, even when the visibility is good. It will ultimately be safer and will produce a much more uniform and precise landing than the pilot's judgment."

The Sperry-RCA automatic direction finder, he said, is nongyroscopic, yet its pointer indicates a given direction as steadfastly as a gyro. "In its simplest terms, it is a radio direction finder which turns its own loop toward the station to which it is tuned. As the loop is oriented to face this station, a pointer on the dial in front of the pilot also turns until it points directly toward the transmitting station. If the instrument is tuned to a transmitting station at the destination of the airplane, the pointer then functions as a compass. The pilot can tune to another station, say, on the beam, and the pointer will swing around and indicate its bearing. From this cross bearing, the pilot can determine his actual location, a feat which cannot even be accomplished with a compass which is a steadfast to one pole only."

Further Pilot Injection Tests

AUTOMOTIVE INDUSTRIES

PILOT INJECTION may be defined as the introduction of a small quantity of fuel into a Diesel engine at some period before dead center, in order to start combustion, and subsequently of the main charge after the flame has established itself. In an article appearing in this section in the December, 1937, issue, researches carried out at Birmingham (England) University were described and results obtained, which are at variance, in some cases, with those found by P. H. Schweitzer, member A.S.M.E., and professor of engineering research at The Pennsylvania State College, and discussed by him in the June 25 and Oct. 29, 1938, issues of *Automotive Industries*.

Schweitzer's tests did not prove, as was reported of the Birmingham findings, that with the pilot injection the delay period of the main injection was nearly decreased to zero. On the contrary, it was found that the decrease in the delay period was insignificant. However, the second tests also showed that pilot injection is effective in reducing combustion knock and in increasing power output, as shown in Figs. 1 and 2.

Professor Schweitzer carried out his experiments on a $3^1/_4 \times 4^1/_8$-in. 900-rpm swirl-chamber Diesel engine with a compression ratio of 15.8 to 1. Two completely independent injection pumps and nozzles were employed. The Bosch pumps were driven from a common shaft, and both had independent injection-timing control. The Bosch nozzles were also identical, and both were mounted in the swirl chamber as shown in Fig. 3. An electromagnetic pickup was mounted in the chamber to indicate the cylinder pressures by means of a cathode-ray oscillograph. Needle-valve lifts were recorded by mounting pick-ups on the valve stem of both spray nozzles. Pressure and needle-lift records were traced from the screen of a Standard-Sunbury cathode-ray indicator, which also permitted throwing a timed degree scale on the screen for reference.

With suitable timing and quantity setting of both pilot spray and main spray, truly astonishing results were obtained. By just switching the pilot spray on and off, the knock could be made to disappear and reappear. It was also found that excellent results can be obtained with pilot injection if high-cetane fuel is used for the pilot spray.

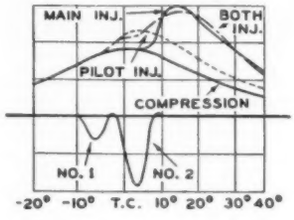


FIG. 1 PILOT INJECTION ELIMINATES KNOCK

	Injection timing, B.T.C.	Injection quantity, mm³ per stroke	M.R.P.R., lb per sq in. per deg
Main injection only.....	—1 deg	22.5	52.0
Pilot injection only.....	—10 deg	3.5	24.5
Main and pilot injection.	—10—1 deg	26.0	36.5

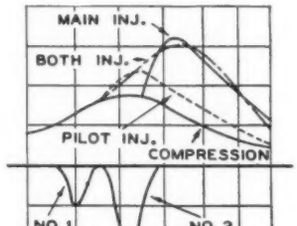


FIG. 2 PILOT INJECTION BOOSTS OUTPUT

	Injection timing, B.T.C.	Injection quantity, mm³ per stroke	M.R.P.R., lb per sq in. per deg
Without pilot injection..	—3 deg	25.2	89.0
With pilot injection....	—13—3 deg	26.8	36.5

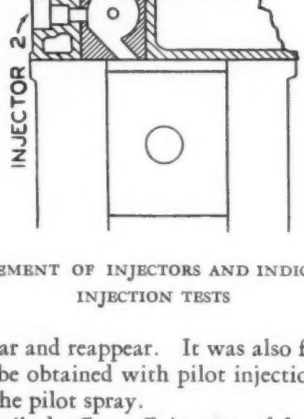


FIG. 3 ARRANGEMENT OF INJECTORS AND INDICATOR IN DOUBLE INJECTION TESTS

The tests described offer sufficient proof for the contention that pilot injection may reduce the combustion knock considerably, and increase the power output appreciably. However, not every application of pilot spray showed such spectacular results as those described. The effect depends greatly on the

timing and quantity setting of both nozzles. For best results it was found that the pilot spray must not be more than 15 per cent of the main spray. It must begin 10 to 15 deg before top center. The main spray must follow by 8 to 10 deg the pilot spray, if 55-cetane fuel is used for both. If high-ignition-quality fuel is used for the pilot spray the spacing should be closer. With adjustments different from these, the benefit was smaller or nil.

Nondestructive Testing

JOINT COMMITTEE ON MATERIALS AND THEIR TESTING (GREAT BRITAIN)

NONDESTRUCTIVE methods of testing was the subject of a symposium, arranged by the Joint Committee on Materials and Their Testing, in London, England, on Nov. 25, 1938. Seven papers were presented which dealt with magnetic and electrical methods, X rays and gamma rays, and acoustic and general methods. There was also a paper on American practice which covered all these methods and their application in the United States.

A paper by B. M. Thornton and his father, Dr. W. M. Thornton, which has been printed by The Institution of Mechanical Engineers and released for discussion recently, describes a new method of nondestructive testing, with special reference to the prevention of boiler explosions, by measuring the thickness of boiler plates or tubes while in position. The instrument, used for the purpose and illustrated in Fig. 4, consists of a rheostat, an ammeter, a switch, and a Cambridge spotlight galvanometer. The method is essentially that of comparing the resistance of a metal wall under test with that of a similarly shaped wall of the same material, of which the thickness is known. Current, usually under 10 amp, is supplied by a 6- or 12-volt battery to two current contacts held against the wall and usually spaced 2 or 3 in. apart. The current in the circuit is adjusted by varying the rheostat or the number of cells in the battery, until the very small potential drop indicated by the deflection of a galvanometer connected to the two potential contacts reaches a predetermined fixed value. From a calibration curve the thickness of the wall corresponding to the current registered by the ammeter is determined.

It was found in practice that the instrument could be used to measure the thickness of mild-steel plates up to $1^1/_4$ in. and of iron castings, up to 3 in. with an accuracy of less than 2 per cent. The degree of accuracy obtained, says Dr. Thornton, justifies him in claiming the method to be almost as good as a micrometer.

Of the other methods of nondestructive testing, that based on the measurement of the damping characteristics of the material is of interest to mechanical engineers. The paper, presented by Dr. F. Förster and Prof. W. Köster and entitled, "Elasticity and Damping in Relation to the State of the Material," is reprinted in the Dec. 2, 1938, issue of *The Engineer*. The method consists of exciting in the specimen under examination a vibration of small amplitude, the decay of which is observed by means of a receiver containing a current amplifier. From the length of time required for the decay of the vibration to half the original amplitude—reinforced by a knowledge of the modulus of elasticity which can be simultaneously deduced from the same readings—a wide amount of information concerning the state of the material tested can, it is claimed, be deduced. For example, change in the internal stress in a test bar can be followed very sensitively by observing the change in the damping characteristics. Again, the onset and growth of intercrystalline corrosion is marked by an immediate and large increase in the damping capacity.

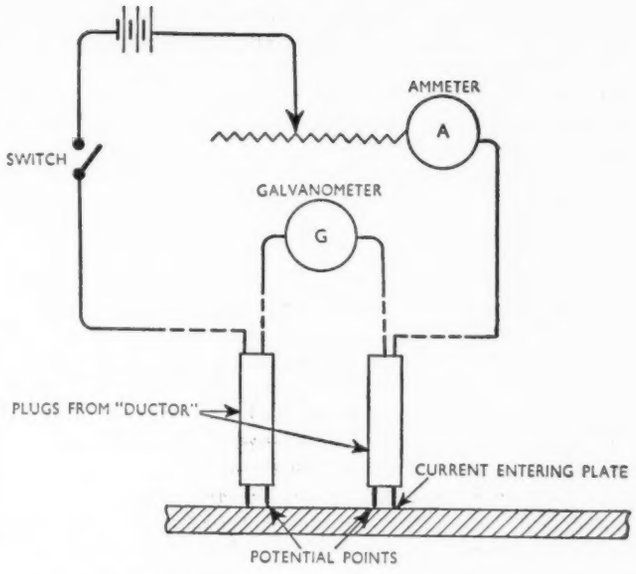


FIG. 4 DIAGRAMMATIC ARRANGEMENT OF THORNTON APPARATUS FOR MEASURING THICKNESS OF METAL WALLS FROM ONE SURFACE ONLY

The method appears to be capable of yielding quantitative results in appropriate cases. For the time being it is a laboratory process, applicable mainly to prepared specimens. With further development, however, it ought to become available for testing selected full-scale jobs under field conditions.

Glass Made More Transparent

SCIENCE

BACK IN 1892, H. D. Taylor discovered that a tarnished photographic lens transmitted more light than a new lens. Since his discovery, several workers have investigated means of treating glass surfaces so as to diminish the reflection and consequently increase the transmission of light by the glass. As recently as December, 1938, Dr. Katherine B. Blodgett, of General Electric's Schenectady laboratories, announced a method of coating glass with a thin film of insoluble soap which extinguishes reflected monochromatic light. The day following her announcement, a way of obtaining the same result by evaporating on to glass surfaces thin films of fluorine compounds was reported at the Boston meeting of the American Physical Society by C. Hawley Cartwright and A. Francis Turner, of M.I.T.

The secret of both the M.I.T. and G.E. achievements is the application of films to both surfaces of glass which have a thickness of one quarter wave length of light. The films are themselves invisible and can only be seen, in slightly greater thickness, as the brilliant colored patterns which they produce by interference, such as that observed in a pool of water covered by an oil film. Potential uses for this more transparent glass might be found in show windows, automobiles, picture frames, telescopes, and cameras.

Dr. Blodgett reported that a film built according to her method completely extinguishes the reflection of sodium light, and nearly eliminates all visible light of other wave lengths. When a plate of ordinary glass was placed a few inches from a 6000-lumen sodium-vapor lamp, with a dark background behind the plate, the glass reflected a bright glare of yellow light, whereas if the glass were coated with a nonreflecting film the coated area would appear as black as black velvet. A stripe of

this type of film, built on a plate of glass, increased the transmission of light from 92 per cent for clean glass to 99.2 per cent for the film-coated glass. When one looked through the glass at the sky or at a sheet of white paper, the stripe had the appearance of clean glass, and the clean glass on either side of the stripe appeared to be slightly smoked.

The only disadvantage to both methods is the impermanency of the films. However, further research may eventually overcome this difficulty.

Wood-Plastic Propeller Blades

SOCIETY OF AUTOMOTIVE ENGINEERS

WEIGHT of airplane propellers has become an important problem because of the trend toward engines of larger size and greater output. It has been shown that as engines increase in power, the weight of the propellers, geometrically similar and of the same material, increases more rapidly than the engine power. Recently, engineers of the Schwarz Company in Germany have developed a new lightweight propeller made of wood and synthetic plastic which makes possible a weight saving of as much as one third in the larger sizes, according to Fred E. Weick in a paper presented by him at the annual meeting of the Society of Automotive Engineers in Detroit, Jan. 9–13, 1939. Besides being used in one-piece-construction propellers, the new type of blades has been used successfully with controllable-pitch hubs.

The Schwarz blade consists essentially of a main core of laminated spruce or other light wood, which merges by means of a long scarf joint into a root of impregnated and compressed hardwood (called compreg). The compreg root is threaded and screwed into a steel ferrule which supports the blade in the hub. The rest of the blade is completely covered with a heavy coating of reinforced cellulose-acetate sheet, the leading edge also being armored with a flush strip of metal. Thus the wood core is well protected against climatic conditions and warping, as well as against injury due to contact with pebbles, cinders, sand, rain, hail, and sea water.

The compreg is made in slabs from laminated layers of one-eighth-inch thick hardwood veneer. Various hard woods, including beech, birch, and maple, have been satisfactorily used. Experiments in the United States indicate that sugar maple obtained from certain selected areas gives a uniformly strong product. The values of the modulus of rupture in bending, obtained with compreg specimens $^1/_2 \times {}^1/_2$ in. in section and 7 in. between supports, range from 35,000 to 60,000 psi. The highest value, it is interesting to note, is about the same as that for duralumin. In certain cases, longitudinal shearing strengths as high as 11,000 psi have been obtained on specimens. The modulus of elasticity of compreg has been found to range from 3,000,000 to 4,000,000.

The blade outside of the steel ferrule at the root is protected by a coat of cellulose-acetate plastic reinforced by linen fabric embedded within it, the whole being approximately 0.04 in. thick. The covering is applied in a soft state and is maintained under pressure for a considerable time so that it is forced into the outer pores of the wood. After curing, the surface is smoothed down and coated with a synthetic enamel.

The Schwarz type of leading-edge metal protecting strip is relatively thick and narrow so that it can flex without buckling or cracking. It is attached by soldering to a wider piece of wire mesh which is tacked to the blade and later embedded in the cellulose-acetate covering. The mesh used is very flexible and durable, each strand being a cable composed of fine bronze wires twisted around a string core.

For propellers operating at high tip speeds, thin-tip airfoil sections are desirable in order to hold the compressibility effect to as small a value as possible. Tip sections having thickness-chord ratios of 8 or 9 per cent instead of the usual 12 per cent can be used satisfactorily if their rigidity is increased by replacing the linen fabric reinforcing in the plastic covering by a finely woven steel-wire mesh.

While the greatest advantage of these composite wood and plastic blades is probably their lightweight, solid duralumin blades ordinarily being about 50 per cent heavier, they have other attractive features too, such as their tendency to damp out vibrations, their freedom from fatigue difficulties, and the ease and low cost with which new or experimental designs can be constructed for special purposes. With thousands of one-piece and controllable-pitch Schwarz propellers in service, there is said to be no case on record of ice forming on them, even when other parts of the airplane were covered.

Load Capacity of Gears

A.S.M.E. FALL MEETING, PROVIDENCE, R. I.

GEAR DESIGN PROCEDURE involves many factors, such as load-carrying ability of the gear, the availability of various kinds of gears made of different materials, and economic considerations. Several systems and formulas have been developed, but it remained for W. P. Schmitter, assistant chief engineer, The Falk Corporation, to correlate the various practices and formulas in the spur, helical, bevel, and worm gear fields, in a paper which he presented at the Fall Meeting of The American Society of Mechanical Engineers in Providence, R. I., Oct. 5–7, 1938.

Discussing factors influencing choice of the type of gear, Mr. Schmitter says that cost is one of the main items which must be considered by the designer. Whether a gear is to be of the parallel-shaft or right-angle type will depend upon the best positions of connected equipment, as determined from the cost of floor space, material flow, operator's time, etc. When a right-angle drive is indicated, a choice must be made between the worm, straight-bevel, or spiral-bevel gear. If the ratio is high, a two-step, spiral-bevel, single-helical drive gear must also be considered. The cost of power will determine whether a gear drive of this type will offset a difference in first cost as against the less efficient worm gear. In a choice between spiral or straight bevel gears, pitch-line velocities will frequently be the determinant.

Similar treatment is required in the case of parallel-shaft drives. The spur gear has been found useful where speeds are low and conditions permit relatively inexpensive mounting. As compared with helical gearing, its capacity falls off rapidly with speed. Where the pinion is free to float, the herringbone type is preferred, as its self-absorbing thrust properties eliminate the need for thrust-sustaining bearings. The single helical gear is necessary where both shafts are restrained axially. Either type is suitable for peripheral speeds up to 10,000 ft per min and higher. The herringbone is of slightly lower cost and permits of greater face width for a given center distance with the same degree of concentrations from deflections.

The internal gear has been found advantageous where short center distances must be maintained, or where its directional properties are desirable. It permits the transmission of larger power for the same proportions as the external type, but this is more than offset by its additional cost. Planetary types frequently make use of spur or helical internal gears.

It is obvious that the designer is handicapped in making a choice as to type if he does not have at his command formulas

TABLE 1 GEAR CAPACITY FORMULAS

TYPE OF GEAR	FORMULA BASIS	FORMULA NO.	FORMULA	APPLICATION	REFERENCES – PUBLICATIONS AND TEXTBOOKS
HELICAL AND HERRINGBONE	DURABILITY	1	$HP = \frac{C_m \times C_f \times PD_p^{1.8} \times C_v \times C_i \times FW \times RPM}{315{,}000}$	FOR GENERAL APPLICATION WHERE TOOTH PROPORTIONS ARE NOT KNOWN OR WHERE EXACT RESULTS ARE NOT REQUIRED.	COMPLETE DERIVATION OF THE THREE RATIONAL HORSEPOWER CAPACITY FORMULAS IS FOUND IN "HELICAL AND HERRINGBONE SPEED REDUCER RATINGS" BY W.P. SCHMITTER, ANNUAL MEETING – A.G.M.A., MAY, 1936 AND "DETERMINING CAPACITY OF HELICAL AND HERRINGBONE GEARING" BY W.P. SCHMITTER MACHINE DESIGN – JUNE AND JULY – 1936
		2	$HP = \frac{C_m \times C_q \times C_f \times C_p \times PD_p^{1.8} \times C_v \times C_i \times FW \times RPM}{126{,}000}$	THIS FORMULA IS BASED ON AVERAGE CONTACT LENGTH WHICH IS $C_q = \frac{.95 \times LA}{NBP}$	
		3	$HP = \frac{C_m \times C_{l\,min} \times C_c \times C_{pa} \times PD_p^{1.8} \times C_v \times C_i \times FW \times RPM}{126{,}000}$	FOR USE WHEN DETAILED STUDIES ARE REQUIRED. SUCH AS TECHNICAL COMPARISONS. FORMULA IS BASED ON MINIMUM CONTACT LENGTH	
		4	$HP = K_r \, D_p \, F_i$	SIMPLIFIED FORM OF ABOVE FORMULAS FOR STANDARDIZED TOOTH FORMS AND MATERIAL HARDNESS. USED FOR RATING HELICAL AND HERRINGBONE SPEED REDUCERS.	RECOMMENDED PRACTICE OF THE AMERICAN GEAR MANUFACTURERS ASSOCIATION FOR THE RATING OF HELICAL AND HERRINGBONE GEAR SPEED REDUCERS.
		5	$HP = \frac{CD_i^3 \times FW \times RPM}{386 \times C_s} \times \frac{GR}{(GR+1)^3}$	FOR HIGH SPEED HERRINGBONE REDUCERS. C_s VARIES FROM 1.5 TO 2.5 DEPENDING ON NATURE OF SERVICE	
		6	$W_w = \frac{D \times F_e \times K \times Q}{\cos^2 \Psi}$	W_w IS THE LIMITING LOAD FOR WEAR – TO BE USED IN CONJUNCTION WITH W_d THE DYNAMIC LOAD FORMULA SHOWN BELOW. WEAR LOAD W_w SHOULD NOT BE LESS THAN DYNAMIC LOAD W_d	MANUAL OF GEAR DESIGN – SECTION THREE BY EARL BUCKINGHAM
		7	$W_d = \frac{.05 \times V(W \times F_e \times C \times \cos^2\psi)/\cos\Psi}{.05 + V + \sqrt{W \times F_e \times C \times \cos^2\Psi}} + W$	W_d IS THE MAXIMUM MOMENTARY LOAD SET UP BY THE OPERATING OR DYNAMIC CONDITIONS, W BEING THE APPLIED LOAD (TANGENTIAL). W_d SHOULD NOT EXCEED W_w	
	STRENGTH	8	$HP = \frac{S_t \times X \times Z \times F \times N \times T}{K \times P \times 126{,}000}$	FOR INDUSTRIAL APPLICATION USING 20° PRESSURE ANGLE, FULL DEPTH TEETH AND STANDARDIZED MATERIALS AND HARDNESS	BRITISH STANDARD SPECIFICATION FOR MACHINE CUT GEARS
		9	$\frac{TP}{FW} = \frac{Z \times X \times S_t}{K}$	THE SAFE LOAD PER INCH OF FACE FOR HELICAL AND HERRINGBONE GEARS	
		10 & 11	$DP = \frac{0.157 \times F \times N \times S_b}{TP}$ WHICH MAY ALSO BE EXPRESSED AS: $HP = \frac{S_b \times FW \times PD_p \times RPM\,(pinion)}{804{,}000 \times DP}$	EMPIRICAL FORMULA FOR CHECKING PITCH SELECTIONS AND DETERMINING H.P. CAPACITY BASED ON PITCH	DETERMINING CAPACITY OF HELICAL AND HERRINGBONE GEARING BY W.P. SCHMITTER MACHINE DESIGN, JUNE AND JULY, 1936
		12 & 13	$DP = \frac{K_s \times FW \times PD_p \times RPM\,(pinion)}{HP}$; $HP = \frac{K_s \times FW \times PD_p \times RPM\,(pinion)}{DP}$	FOR USE IN CHECKING PITCH AND H.P. CAPACITY ON HELICAL AND HERRINGBONE SPEED REDUCERS WITH STANDARDIZED MATERIAL HARDNESS.	RECOMMENDED PRACTICE OF THE AMERICAN GEAR MANUFACTURERS ASSOCIATION FOR THE RATING OF HELICAL AND HERRINGBONE GEAR SPEED REDUCERS.
		14	$W_s = .75 \times S_t \times P_n \times F_e \times y \times \cos\Psi$	W_s IS THE LIMITING BEAM LOAD ON TEETH – TO BE USED IN CONJUNCTION WITH W_d THE DYNAMIC LOAD FORMULA SHOWN ABOVE. W_s SHOULD BE GREATER THAN W_d	MANUAL OF GEAR DESIGN – SECTION THREE BY EARL BUCKINGHAM
		15	$HP = \frac{S_b \times X \times Y \times F \times N \times T}{P^2 \times 126{,}000}$	FOR INDUSTRIAL APPLICATION USING 20° PRESSURE ANGLE, FULL DEPTH TEETH AND STANDARDIZED MATERIALS AND HARDNESS	BRITISH STANDARD SPECIFICATION FOR MACHINE CUT GEARS
		16	$\frac{TP}{FW} = \frac{Y \times X \times S_b}{DP}$	THE SAFE LOAD PER INCH OF FACE FOR STRENGTH	

TYPE OF GEAR	FORMULA BASIS	FORMULA NO.	FORMULA	APPLICATION	REFERENCES – PUBLICATIONS AND TEXTBOOKS
SPUR	DURABILITY	17	$W_w = pd \times FW \times K \times Q$	FORMULA FOR LIMITING WEAR LOAD. TO BE USED IN CONJUNCTION WITH DYNAMIC LOAD FORMULA SHOWN BELOW. WEAR LOAD W_w SHOULD NOT BE LESS THAN DYNAMIC LOAD W_d	RECOMMENDED PRACTICE OF THE AMERICAN GEAR MANUFACTURERS ASSOCIATION FOR COMPUTING LOAD CARRYING ABILITY OF METAL SPUR GEARS
		18	$W_d = \frac{.05 \times PLV \times (FW \times C + W)}{.05 \times PLV + \sqrt{FW \times C + W}} + W$	FORMULA FOR TOTAL DYNAMIC LOAD IN POUNDS FOR OPERATING CONDITIONS WITH APPLIED LOAD W (TANGENTIAL TOOTH LOAD). W_d SHOULD NOT EXCEED W_w FOR ALLOWABLE APPLIED LOAD	
		19	$HP = \frac{S_t \times X \times Z \times F \times N \times T}{K \times P \times 126{,}000}$	FOR INDUSTRIAL APPLICATIONS USING 20° PRESSURE ANGLE, FULL DEPTH TEETH AND STANDARDIZED MATERIALS AND HARDNESSES.	BRITISH STANDARD SPECIFICATIONS FOR MACHINE CUT GEARS
		20	$\frac{TP}{FW} = \frac{Z \times X \times S_t}{K}$	THE SAFE LOAD PER INCH OF FACE FOR SPUR GEARS.	
		21	$HP = K_r \, D_p \, F_i$	FORMULA FOR RATING SPUR GEAR SPEED REDUCERS HAVING STANDARDIZED TOOTH FORMS, MATERIALS AND HARDNESSES	RECOMMENDED PRACTICE OF THE AMERICAN GEAR MANUFACTURERS ASSOCIATION FOR THE RATING OF SPUR GEAR TYPE SPEED REDUCERS.
	STRENGTH	22	$HP = \frac{S_b \times X \times Y \times F \times N \times T}{P^2 \times 126{,}000}$	FOR INDUSTRIAL APPLICATIONS USING 20° PRESSURE, FULL DEPTH TEETH AND STANDARDIZED MATERIALS AND HARDNESSES	BRITISH STANDARD SPECIFICATIONS FOR MACHINE CUT GEARS
		23	$\frac{TP}{FW} = \frac{Y \times X \times S_b}{P}$	THE SAFE LOAD PER INCH OF FACE FOR STRENGTH OF SPUR GEARS.	
		24 & 25	$DP = \frac{FW \times K_s \times PD_p \times RPM\,(pinion)}{HP}$; $HP = \frac{K_s \times FW \times PD_p \times RPM\,(pinion)}{DP}$	FORMULAS FOR CHECKING PITCH AND H.P. CAPACITY OF SPUR GEAR SPEED REDUCERS.	RECOMMENDED PRACTICE OF THE AMERICAN GEAR MANUFACTURERS ASSOCIATION FOR THE RATING OF SPUR GEAR SPEED REDUCERS.
		26	$W_s = S_t \times CP \times FW \times Y$	LEWIS FORMULA FOR STRENGTH USED WITH TABLE FOR ENDURANCE LIMIT STRESS S_t. W_s SHOULD NOT BE LESS THAN DYNAMIC LOAD W_d.	RECOMMENDED PRACTICE OF THE AMERICAN GEAR MANUFACTURERS ASSOCIATION FOR COMPUTING THE LOAD CARRYING ABILITY OF METAL SPUR GEARS.
PLANETARY	DURABILITY	27	$HP = K_r \, D_p \, F_i$	FORMULA FOR RATING PLANETARY GEAR SPEED REDUCERS HAVING STANDARDIZED TOOTH FORMS, MATERIALS AND HARDNESSES	RECOMMENDED PRACTICE OF THE AMERICAN GEAR MANUFACTURERS ASSOCIATION FOR THE RATING OF PLANETARY GEAR SPEED REDUCERS.
	STRENGTH	28 & 29	$DP = \frac{FW \times K_s \times PD_p \times RPM\,(pinion)}{HP}$; $HP = \frac{K_s \times FW \times PD_p \times RPM\,(pinion)}{DP}$	FORMULA FOR CHECKING PITCH AND H.P. CAPACITY OF PLANETARY GEAR SPEED REDUCERS.	

TYPE OF GEAR	FORMULA BASIS	FORMULA NO.	FORMULA	APPLICATION	REFERENCES – PUBLICATIONS AND TEXTBOOKS
SPIRAL AND STRAIGHT BEVEL GEARS	DURABILITY	30	$f_o = 470\sqrt{\frac{N}{P}}$	BASIC UNIT LOAD PER INCH OF FACE WIDTH FOR SPIRAL BEVEL GEARS. TO BE USED WITH MODIFYING FACTORS AS SHOWN BELOW.	RECOMMENDED PRACTICE OF THE AMERICAN GEAR MANUFACTURERS ASSOCIATION FOR COMPUTING ALLOWABLE TOOTH LOADS AND STRESSES IN STRAIGHT AND SPIRAL BEVEL GEARS FOR INDUSTRIAL APPLICATION.
		31	$f_p = f_o \times C_m \times C_s \times C_v \times (C_m)$	ALLOWABLE UNIT LOAD PER INCH OF FACE FOR SPIRAL BEVEL GEARS FOR INDUSTRIAL APPLICATION.	
		32	$f_p = 0.80 \times f_o \times C_m \times C_s \times C_v \times (C_m)$	ALLOWABLE UNIT LOAD PER INCH OF FACE FOR STRAIGHT BEVEL GEARS FOR INDUSTRIAL APPLICATION	
		33	$HP = \frac{S_t \times X \times Z \times F \times N \times T \times B}{K \times P \times 126{,}000}$	FOR INDUSTRIAL APPLICATIONS USING STANDARDIZED TOOTH FORMS, MATERIALS AND HARDNESSES. STRAIGHT AND SPIRAL BEVEL GEARS.	BRITISH STANDARD SPECIFICATIONS FOR MACHINE CUT GEARS.
		34	$\frac{TP}{FW} = \frac{Z \times X \times S_t \times B}{K}$	THE SAFE LOAD PER INCH OF FACE FOR STRAIGHT AND SPIRAL BEVEL GEARS.	
	STRENGTH	35	$S_o = \frac{P}{W} \times \frac{A}{A-W} \times \frac{P}{Y}$	FORMULA USED FOR CHECKING BENDING STRESS ON SPIRAL AND STRAIGHT BEVEL GEARS. S_o IS CALCULATED STRESS AT ZERO VELOCITY. S IS ESTIMATED RUNNING STRESS. FORMULAS TO BE USED FOR EXCEPTIONALLY HEAVY LOADS AND HIGH SPEEDS.	RECOMMENDED PRACTICE OF THE AMERICAN GEAR MANUFACTURERS ASSOCIATION FOR COMPUTING ALLOWABLE TOOTH LOADS AND STRESSES IN STRAIGHT AND SPIRAL BEVEL GEARS FOR INDUSTRIAL APPLICATION
		36	$S = \frac{1200 + V}{1200} \times S_o$		
		37	$HP = \frac{S_b \times X \times Y \times F \times N \times T \times B}{P^2 \times 126{,}000}$	FOR INDUSTRIAL APPLICATIONS USING STANDARDIZED TOOTH FORMS, MATERIALS AND HARDNESSES STRAIGHT AND SPIRAL BEVEL GEARS.	BRITISH STANDARD SPECIFICATIONS FOR MACHINE CUT GEARS
		38	$\frac{TP}{FW} = \frac{Y \times X \times S_b \times B}{P}$	THE SAFE LOAD PER INCH OF FACE FOR STRAIGHT AND SPIRAL BEVEL GEARS	
WORM	DURABILITY	39	$HP = \frac{n}{m} \times K_1 \times q \times V$	FOR INDUSTRIAL APPLICATIONS OF HEAVY DUTY WORM GEAR SPEED REDUCERS.	RECOMMENDED PRACTICE OF THE AMERICAN GEAR MANUFACTURERS ASSOCIATION FOR FORMULAE AND SPECIFICATIONS FOR THE DESIGN AND RATING OF HEAVY DUTY WORM GEAR SPEED REDUCERS.
		40	THERMAL $HP = \frac{K_2}{m+3}$	FORMULA FOR THERMAL CAPACITY LIMITATION	

Symbols for Schmitter, A.G.M.A., and Buckingham Formulas

A = addendum
C = deformation and various other factors, C_q contact length, C_c curvature, C_i combined inbuilt, C_m material, C_r ratio, C_s service, C_v velocity
CD_i = center distance
CL = contact length
D = pinion pitch diam, in.
D_e = combined factor for pinion diameter, velocity, and rpm
DP or P = diametral pitch
F or FW = face width, in.
F_e = active face width, in.
F_i = combined face width and inbuilt factor
f_o = basic unit load per inch face width, spiral bevel gears, psi
f_p = allowable unit load, spiral bevel gears, psi
f_t = allowable unit load, straight bevel, psi
GR = gear ratio
HP = horsepower
K = load-stress factor
K_r = combined material, tooth form, ratio factor
K_s = 0.036 for 225, 0.04 for 245, 0.045 for 280, 0.05 for 315, and 0.054 for 350 Bhn pinion, respectively
N = number of teeth
NBP = normal pitch length
P_n = normal diametral pitch
P or DP = diametral pitch
PD_p or pd = pinion pitch diameter
PLV or V = pitch-line velocity, fpm
Q = ratio factor curvature of tooth profiles
RPM = revolutions per min
S = running stress, est'd
S_o = calculated stress at zero velocity
S_t = bending endurance limit of material, psi
S_s = maximum shear-stress below surface
TP = total tangential pressure on teeth
W = total applied load
W = maximum momentary tooth load, lb
W_s = limiting beam load on teeth, lb
W_w = limiting load for wear
Y or y = Lewis tooth-form factor
Ψ = helix angle

Symbols for British Standard Formulas

B = bevel-gear factor
HP = horsepower
F or FW = face width, in.
K = pitch factor
N = speed, rpm
P = diametral pitch
S_c = basic surface-stress factor
S_b = basic bending-stress factor
T = number of teeth in wheel (or pinion)
X = speed factor
Y = strength factor
Z = zone factor

which lead to equitable proportions in the several types. It does not help matters if he has to select worm gears by a method which leads to relatively short life, and helical gears by one which provides for a long life. Despite excellent strides made by the American Gear Manufacturers' Association and others, practices are not yet sufficiently developed to assure correlative results between the several types. The British gear industry, realizing the need for such information, has developed carefully formulated methods applicable to the several types of gearing. This work, which was carried on by the British Standards Institute, has been simplified in no small degree by standardization of arbitrary tooth forms.

After devoting the remainder of his paper to a comprehensive analysis of the various factors affecting the load-carrying capacities of gears, Mr. Schmitter presents a series of gear-capacity formulas for the different types of gears as shown in Table 1. The nomenclature for these formulas is included with the exception of those for formulas 39 and 40.

CO_2 From Natural Gas

PACIFIC COAST GAS ASSOCIATION

SEVERAL TIMES in this section, articles have appeared in which a process of recovering carbon dioxide from flue gas, known as the Macmar process, has been described. Now, according to a paper by A. F. Michael, appearing in the Proceedings of the Pacific Coast Gas Association for 1938, a new plant has been constructed in Los Angeles for the sole manufacture of liquid and solid carbon dioxide from natural gas. There is something approaching the fantastic in a process wherein gas, which has its origin in combustion at temperatures in the neighborhood of 2300 F, becomes solid matter with a temperature of 110 F below zero. A flow diagram of the processes involved is shown in Fig. 5.

In its dual rôle natural gas is fired under two Stirling water-tube boilers, rated at 100 hp each, which are equipped with full-automatic multijet burners. Steam generated at 150 lb pressure provides most of the energy required in the plant operations. The flue gases from the boilers containing an average of 11 per cent CO_2 enter a stack manifold from which, by means of an arrangement of dampers, all or any part of them are directed into the processing equipment to become the finished products of the plant.

The manufacturing process is made up of three more or less distinct phases: (1) The production and separation of CO_2 gas from the products of combustion; (2) the production of liquid CO_2 from the gas; and (3) the manufacture of the solid form from the liquid.

Beginning with the first phase, flue gases are carried through a duct to the scrubber, a large water-sealed concrete box filled with limestone which is sprayed with water. The gases enter at the bottom of this unit, pass up through the bed of limestone, and out near the top. This washing action cleans the gases and cools them down to about 115 F and the limestone chemically removes any traces of impurities.

Leaving the scrubber the gases pass through a large positive blower and into the absorption tower, which is a large cylindrical tank approximately 14 ft in diameter and 110 ft high filled with coke. The bottom of the tank contains a solution of potassium carbonate or lye to a depth of about 2 ft. This solution is constantly pumped from the bottom to the top of the tower where it is sprayed over the coke bed and filters back down through the bed to the base of the tower. The flue gases enter at the base of the tower and pass up through the coke bed. CO_2 is absorbed in the lye solution and the remaining elements in the flue gases pass out through the top of the tower.

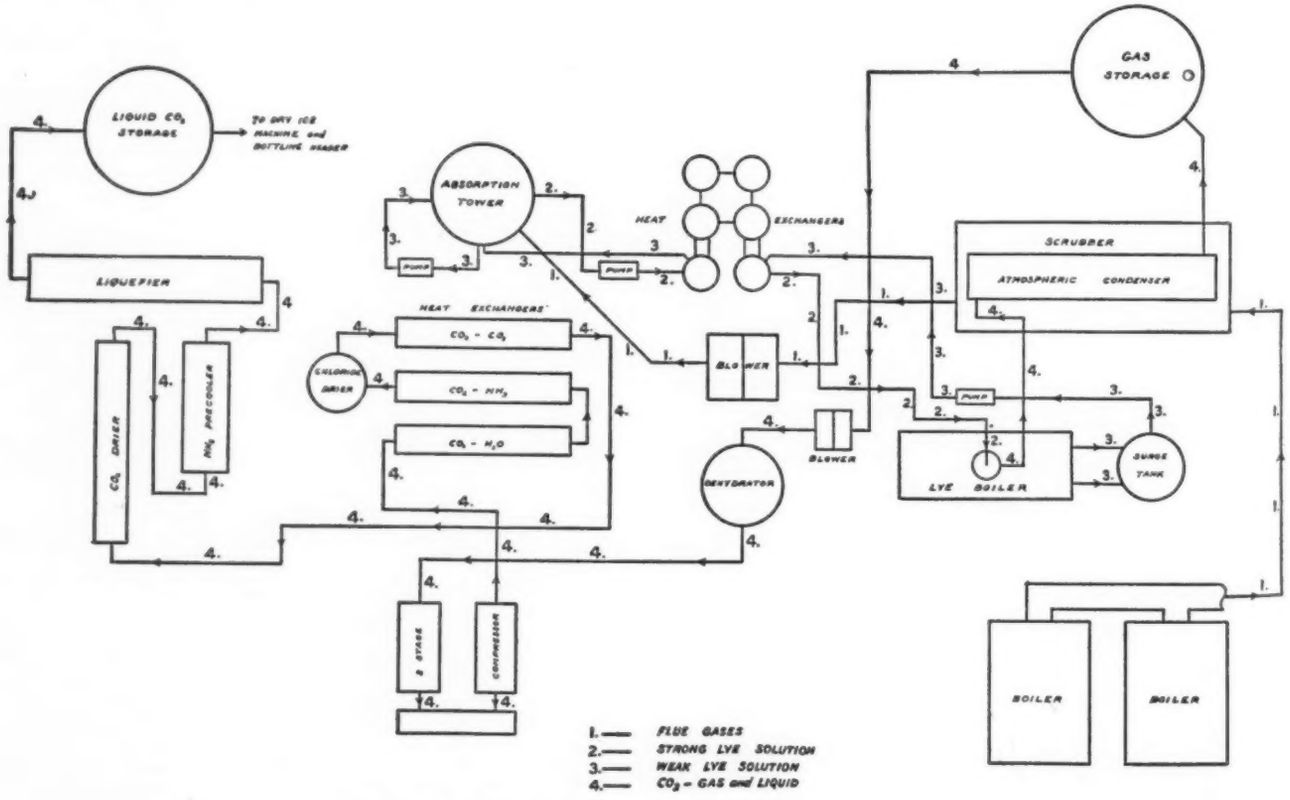


FIG. 5 FLOW DIAGRAM OF PROCESSES INVOLVED IN THE MANUFACTURE OF CO_2 FROM NATURAL GAS

The strong lye solution, that is, the solution which has absorbed its load of CO_2, is picked up near the liquid level in the base of the tower and pumped to the lye boiler where it is heated to about 210 F by means of steam coils. The CO_2 is boiled off and the weak lye solution, stripped of its load of CO_2, drains into a surge tank under the boiler and is pumped back to the absorption tower. Between the boiler and the tower is a series of heat exchangers wherein the strong lye solution going to the boiler is heated by the weak lye solution returning to the tower. This preheats the strong lye to about 180 F and cools the weak lye down to about 90–95 F, at which temperatures absorption is found to be most satisfactory. The mixture of CO_2 gas and water vapor leaving the lye boiler passes through a set of water-cooled coils where most of the water vapor is condensed and removed and enters a water-sealed gas storage tank as nearly pure CO_2 gas.

In the second phase, the liquefying process may be one either of compression of the gas to high pressures at ordinary temperatures or a combination of compression and refrigeration at lower pressures and temperatures. Using the latter methods at the new plant, the CO_2 gas is pumped from the storage tank by a small positive blower and discharged into a dehydrating unit. Here it is bubbled up through a brine solution kept at a temperature of 29 F by an automatically controlled ice-machine unit and essentially all water vapor is condensed and removed.

From the dehydrator the gas goes into a two-stage steam-driven compressor where its pressure is raised to about 210 lb per sq in. Discharged from the compressor at a temperature of about 170 F it enters a series of shell and tube heat exchangers where it is cooled successively by water, ammonia, and "blow-back" CO_2 gas from the "dry ice" machine, to temperatures somewhere near 0 F. Leaving the last of the heat exchangers, the CO_2 enters a long cylindrical tank known as the drier where the last traces of water vapor possible to remove are condensed and drained off. After passing through a second tank, known as the ammonia precooler, the CO_2 gas enters a series of ammonia-cooled coils of considerable surface area where it becomes liquid and flows by gravity into the liquid CO_2 tank where it is kept at a pressure of approximately 210 lb per sq in. and a temperature of —24 F ready for the final steps of bottling or conversion to the solid form.

The "dry ice" machine consists essentially of a cylinder with hydraulically operated piston and cylinder head. In operation the cylinder head is held in place and the piston is drawn back the full length of its travel. Liquid CO_2 direct from the storage tank is then injected into the cylinder through expansion nozzles and the expansion of a portion of the liquid to gas cools the remainder so that it solidifies and falls as snow in the cylinder. Approximately one half the weight of liquid entering the cylinder becomes snow, the remainder as cold gas returns through the "blowback" heat exchanger to the gas storage tank. When sufficient snow has been formed the liquid is shut off and the snow is compressed into cakes, 19.6 in. square.

For bottling, the liquid CO_2 is passed through a pump where its pressure is boosted to approximately 500 lb per sq in. and delivered into a header from which the steel cylinders or bottles are filled. The high pressure is necessary to overcome gas pressures developed in the containers during the filling operation.

New U. S. Semiautomatic Rifle

ARMY ORDNANCE

PLANS for rearmament by the United States Government will, probably, also include increased production of the new semiautomatic caliber 0.30 rifle invented by John C. Garand, an ordnance engineer at the Springfield Armory, and officially adopted by the U. S. Army last year in place of the Springfield, caliber 0.30, M1903 rifle. In an article appearing in the November-December, 1938, issue of *Army Ordnance*, which describes the new rifle, it is said that funds were provided last year for the manufacture of 7500 rifles. Additional funds have been made available for Springfield Armory to purchase more and better shop equipment, such as modern machines, jigs, fixtures, tools, and gages, for the manufacture of the new rifles on a larger scale.

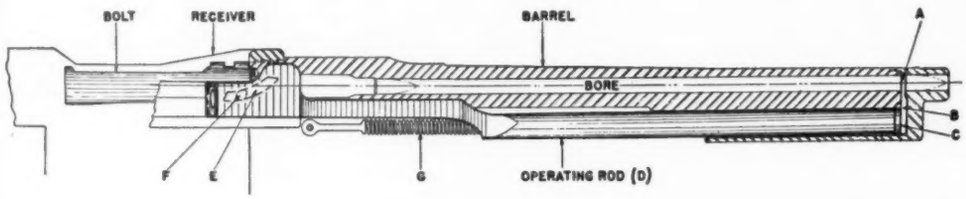


FIG. 6 DIAGRAM OF THE PRINCIPLE OF OPERATION OF THE NEW U. S. M1 RIFLE

The new M1 caliber 0.30 rifle, as it is officially called, is a gas-operated, clip-fed, self-loading, shoulder weapon slightly over nine pounds in weight. It fires the same ammunition as the Springfield rifle and all standard U. S. caliber 0.30 machine guns. The ammunition is supplied in 8-round, reversible, *en bloc* clips which are fed by hand into the magazine of the rifle. Upon being inserted, the clip depresses the follower which in turn releases a catch, allowing the bolt to go forward under the action of a compressed spring, stripping the top cartridge from the clip and chambering it. When the last round in the clip is fired and the empty case is ejected, the clip also is ejected and the bolt is retained in the open position ready for the insertion of the next loaded clip.

The semiautomatic or autoloading action of the rifle is accomplished by a mechanical arm or "robot" called the operating rod. This component takes the place of the human arm in operating the bolt, the power being obtained from the propellent powder gases. The diagrammatic sketch shown in Fig. 6, while not a drawing of the actual parts used in the rifle, shows the cycle of operation. When the cartridge is fired, the bullet is propelled down the bore. As the rear end of the bullet reaches position *A* as shown in the drawing, the powder gases enter chamber *B* and impinge against piston *C*, driving it to the rear. This piston is at one end of, and also an integral part of, the operating rod *D*. The other end of the rod contains a slotted cam *E*, into which projects a cam-shaped extension of one of the bolt-locking lugs *F*. In traveling to the rear, this slot cams the bolt-locking lug extension upward, rotating the bolt until the bolt-locking lugs are disengaged from their locking recesses in the receiver. The operating rod continues to the rear with the bolt which in turn extracts and ejects the empty cartridge case and cocks the hammer. During the rearward travel of the rod, the spring *G* is compressed, thereby storing up sufficient energy to return the rod, bolt, and a new cartridge to the firing position. The only manual operations performed are those required to pull the trigger for each shot and to insert a new clip after every eighth round.

Features of the M1 rifle which stand out in comparison with other similar rifles include reliability, general appearance, good balance, the small "kick," and short receiver. The M1 rifle has 72 components including springs, screws, and pins as com-

pared with 92 for the Springfield. It is probably the easiest to disassemble of any military semiautomatic ever developed, requiring only a total of 12 sec to remove the trigger-guard group, stock, operating rod, and bolt. In all comparative tests between the semiautomatic and the bolt-action shoulder rifle—i.e., between the M1 and the M1903 Springfield—conducted by the Ordnance Department as well as the using services, the new rifle clearly demonstrated its marked superiority. It was found that for short periods of fire the M1 has the value of approximately three bolt-action rifles because of its capability of firing anywhere from 40 to 100 aimed shots within one minute.

It is interesting to note that the M1 rifle is the third one developed by Mr. Garand since 1920. His first two semiautomatic rifles and the Pedersen rifle were described by Major J. S. Hatcher in an article which appeared in the August, 1931, issue of MECHANICAL ENGINEERING.

Internal-Combustion Nutcracker

AGRICULTURAL ENGINEERING

ENGINEERS of the California Agricultural Experiment Station recently solved the cracking and meat picking problem of the California walnut growers with the development of an experimental machine that cracks walnuts by exploding them. Designed by Roy Bainer and C. E. Barbee and described by them in the January, 1939, issue of *Agricultural Engineering*, the new machine will do much to simplify the present practice in which the nuts are passed through a mechanical cracker adjusted to rupture the nut walls with as little injury as possible to the meat lobes. The cracked nuts are then delivered to picking tables where the meats are separated by hand labor. The tediousness of this task is illustrated by the output of the workers which averages about 35 lb of meat per worker per day. That is the reason why only approximately one half of the 70,000,000 lb of walnuts produced annually in California are sold as shelled nuts.

Since external forces had been explored for the last twenty years as a means of cracking nuts, it occurred to Bainer and Barbee that some thought should be given to the possibilities of creating differential pressures on opposite sides of the nut wall by some internal force. Naturally, the use of some explosive gas injected into the nut cavities suggested itself as a result of this approach. Preliminary experiments readily showed that the injection of an explosive gas with subsequent injection set up a force sufficient to shatter the nut walls and cause the relatively intact meat lobes to drop free of the shells which were thrown some distance away.

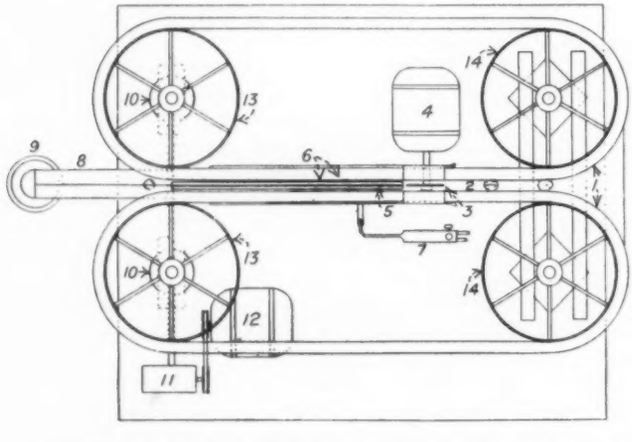


FIG. 7 TOP VIEW OF INTERNAL-COMBUSTION NUTCRACKER

A machine, employing this principle, was eventually designed and built. Referring to Fig. 7, it will be seen that two parallel belts (1) running in a vertical position and at a speed of 110 fpm convey the nuts through the machine. An adjustable saw table (2) regulates the depth of a saw cut that is made through the shell. A slot 0.065 in. wide is cut through the shell as the nut moves over the circular saw (3) which is driven from a shaft of an electric motor (4). Upon leaving the saw the nut, guided by the belt, rides on a guide rib 0.055 in. wide (5) which partially fills the slot cut by the saw. Apertures, 0.050 in. in diameter (6), through the guide rib admit the explosive mixture of oxygen and acetylene to the nut from the mixing valve (7). The nut continues to ride along the guide rib (5) which now seals the slot in the nut, thus retaining the gas within. The gas-filled nut is discharged from the belts onto a slide (8) which conveys it to a flame (9) where ignition takes place. The resulting explosion shatters the nut. Advantage may be taken of the force of the explosion for making a partial separation of the nut kernels from the broken shell by having two concentric receptacles below the flame, one to receive the nut kernel as it tends to drop downward after the explosion, and the other, a larger one, to receive the shell which is thrown out laterally due to the force of the explosion.

The belts (1) are driven by pulleys (13) and run over idling pulleys (14). The pulleys (13) are driven through a set of bevel gears (10) mounted on the shaft of a speed-reduction unit (11). An electric motor (12) furnishes power to the speed reduction unit. Approximately 60 per cent of the nut meats come out in whole or half pieces, while the remainder are in rather large pieces. Allowing 2 in. per nut, this machine has a potential capacity of approximately 900 lb of unshelled walnuts per hour. The gas mixture used was less than 25 cu ft per hr.

Millionths of an Inch

GENERAL ELECTRIC COMPANY

DIFFERENCES of millionths of an inch are compared electrically through the recent application of a new G. E. electric-gage head to the tailstock of a Pratt and Whitney measuring machine in the Schenectady tool and gage department of the General Electric Company. This machine was originally built to measure mechanically to 0.00001 inch the lengths of gage standards up to 80 inches, and to compare extremely small differences in length, such as may exist between toolroom standards and factory gages.

Essentially, the machine consists of a heavy bed plate with a movable headstock toward the right end and toward the left a movable tailstock now equipped with the electric gage, as shown in Fig. 8. Differences in length over 0.00001 inch are measured mechanically at the headstock, while by combination of the tailstock and the new electric gage the millionths-of-an-inch differences in length can be compared.

Mounted on the headstock is a microscope with two parallel hairlines for use in accurately positioning the headstock with reference to a given line on a standard 80-in-length bar in which is inserted a steel measuring button at each inch. The headstock spindle is easily adjusted through the convenience of a micrometer screw on which a drum calibrated in ten thousandths of an inch makes vernier readings to 0.00001 in. possible.

The tailstock is used as an end point in measuring gage lengths and once its zero position is set by the headstock it is rigidly clamped in place. The head of the electric gage is

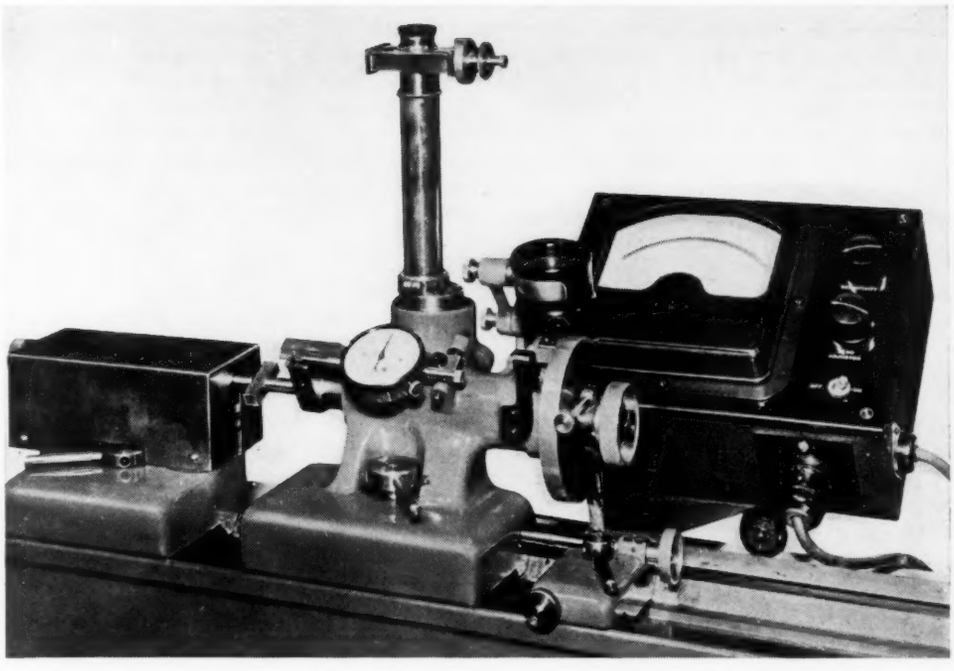


FIG. 8 ELECTRIC TAILSTOCK GAGE USED TO MEASURE MILLIONTHS OF AN INCH

mounted on the tailstock in such a way that the gage spindle is the tailstock spindle. This makes the electric-gage head responsive to the slightest variations in gaging pressure.

Misconceptions About Rubber

A.S.M.E. FALL MEETING, PROVIDENCE, R. I.

ERRONEOUS IDEAS about color, texture, body, and manufacture of many products have grown up in the minds of people, mainly as the result of unfortunate experiences with improperly processed or commercially undeveloped goods. That is why many new products developed in the research laboratories today are not put on the market until further tests have proved their commercial possibilities. Misconceptions about rubber have remained with us through many decades because of the erratic behavior of this material in the early days of its various commercial applications, according to a paper presented at the A.S.M.E. 1938 Fall Meeting in Providence, R. I., by E. G. Kimmich, development engineer, The Goodyear Tire and Rubber Company.

Heat sufficient to melt rubber and pour it into molds is never used. In the production of rubber articles, such treatment would destroy most of the desirable qualities of the material.

Color is no measure of quality. The myth that red rubber is better is still accepted in many quarters. It happens, where color has no intrinsic value in the finished article, that black makes possible the best value for the money spent. Various carbon-black ingredients have a definite reinforcing and toughening effect on rubber and, of course, even so little as one half of one per cent of carbon black will make a deep gray or black stock, whereas contents greatly in excess of this are very desirable for many purposes.

Likewise neither "bloom" nor its absence is a measure of quality. The quality of various rubber articles has come to be identified mistakenly by the presence or absence of bloom which is merely the migration of sulphur, or other compounding ingredients, to the surface. While the bloom may be very objectionable to an occasional specialized use, its presence or absence is no indication of inferiority or guarantee of quality.

The best rubber does not come from wild trees. In the early days of plantations, there was some truth to this widely believed assertion, but for many years now, the finest crude rubber has been produced under scientifically controlled conditions on well managed plantations.

Rubber compounding ingredients are not primarily diluents. There are times when a study of the economic side of the problem will dictate the use of some material to distend the rubber and thus produce the necessary bulk at a lower price and in many such cases make possible a use of rubber which otherwise would be closed to the industry. In general, each compounding ingredient has its specific use to the end of producing a specialized compound for the purpose desired.

Organic accelerators are not to be avoided but rather encouraged because they have made possible some of the remarkable advances in the rubber industry in regard to widening the range of characteristics in the vulcanized compound and in decreasing the time of vulcanization. In some cases, specialized ingredients of this type are used to retard the vulcanization for a predetermined time while some physical adjustment takes place in the uncured article.

Reclaimed rubber is by no means a material of inferior quality. In fact, reclaiming is an important source of raw materials for the rubber industry much the same as scrap iron is for the steel industry. Again, it is a question of economics, because vulcanized rubber, gathered, sorted, and processed in a reclaiming plant, can be restored to usefulness so that in most cases it is merely a case of determining which is the more economical, the use of fresh or reprocessed rubber.

Poll on the Wagner Act

FACTORY

FIFTEEN hundred ballots from representatives of management of large and small plants located all over the United States were tabulated in a poll conducted by *Factory* and the results are reported in that magazine's issue for January, 1938. The two outstanding demands that the poll revealed are "amend the labor law" and "change the board." The results also

show, however, "that management is not opposed to unionization and that most management men see a need for a law to protect labor's organizing rights.

That the labor act has not helped industry, labor, or the public was the opinion expressed in 92, 60, and 92 per cent, respectively, of the answers to the three aspects of this question. Seventy-one per cent of the replies agreed that there is a basic need for a law to protect labor's right to organize and 84 per cent indicated no opposition to unionization.

The three members of the National Labor Relations Board are not viewed with favor: 725 out of 848 would not continue J. Warren Madden on the board, 750 out of 825 felt the same way about Edwin S. Smith, and 753 out of 831 would get rid of Donald W. Smith.

When asked about changes of the law 76 per cent voted for its amendment, 23 per cent for its repeal, and 1 per cent to leave it unchanged. There was an overwhelming majority opinion, 91 per cent, in favor of an "amendment to revise the Labor Board set up with two distinct branches, one to prosecute and one to judge." Equally emphatic opinions were expressed on other proposed changes. A majority of replies (83.3 per cent) indicated that managers would rather deal with craft than with the industrial type of union.

Factory Layout and Safety

1938 A.S.M.E. ANNUAL MEETING, COMMITTEE ON SAFETY

SAFETY in factory layout does not consist of a series of rules and regulations, but is an application of common sense coupled with a safety conscious mind and a reasonable degree of experience, declared F. J. Van Poppelen, industrial engineer, Remington Arms Co., Inc., in his talk presented at safety session, sponsored by the Committee on Safety, of the 1938 Annual Meeting of The American Society of Mechanical Engineers. Industries emphasize the slogans, "safety first" and "quality first," but do not always enforce them because, if they were to do so, many plants would be forced to close their doors. In other words, quality and safety are tempered with economics.

Mr. Van Poppelen proved his point by showing how a program of control of quality in production implies balancing of costs associated with the passing of defective parts or defective final product against increased inspection costs; similarly, the allotment of funds to hazard-elimination projects implies balancing the prospective accidents due to any particular class of hazards against the cost of eliminating these hazards. Further to amplify this unusual statement, he stated that in cases where it is easy to recognize that it pays to reduce a hazard because the cost of reducing it is small as compared to the probability of an accident, the safety viewpoint should prevail exclusively. If the cost of reducing the hazard is excessively high and the possible occurrence of accidents slight, investors can hardly be expected to cherish the safety viewpoint alone.

In laying out a plant, the economics of the particular project will decide, more or less, what form the physical plant will take. The type of the building involved has a fundamental influence on the safety aspects of the layout. It is necessary for the safety engineer to consider the elements that constitute the major hazards found in industrial activity which are traceable to layout in general. These are summarized for 1937 by the National Safety Council thus: Handling objects, 26 per cent; falls, 20 per cent; stepping on or falling against objects, 6 per cent; and falling objects, 8 per cent. The remaining 40 per cent of accidents is attributable to machinery, vehicles, hand tools, and miscellaneous. From these figures, it can be stated that each handling of material which can be eliminated means a proportional elimination of hazards. To eliminate handling involves motion study, which should be an integral part of layout procedure.

A fundamental factor of safe operation is the safety consciousness of the personnel of a factory. If from the top to the bottom of the organization there exists a strong desire to operate safely, then, and only then, will there be safety regardless of factory layout. Safety seldom depends primarily upon layout, but it always depends upon the degree of safety consciousness which exists in the personnel.

Good housekeeping is useful in maintaining safety. A clean and orderly plant is generally a safe plant. Antiquated buildings and obsolete layouts make it somewhat difficult to do a good job of housekeeping, but do not make it impossible. Finally, to secure a safe layout, the safety engineer must not only study the problem of planning and scheduling but see that others in the organization do their part in using the layout safely, just as they would be expected to use a tool safely.

In the discussion which followed the presentation of the paper by Mr. Van Poppelen, one of the discussers, J. M. Roche, safety engineer, The Travelers Insurance Company, outlined thirteen rules which should guide engineers in making factory layouts safe.

While these are only a few of the existing rules, so-called, affecting the safety and efficiency records of plants, they serve to indicate that some rules do exist, and, furthermore, their very nature shows that they are based on common sense and experience.

Engineering Students

THE JOURNAL OF ENGINEERING EDUCATION

STUDENTS, pursuing undergraduate engineering courses in the 122 institutions in the United States and Canada, which furnished information to the Society for the Promotion of Engineering Education, as of Dec. 22, 1938, numbered 84,002, of which 6982 are "evening students." The complete report, published in the January, 1939, issue of *The Journal of Engineering Education*, shows that one quarter of these students were taking courses in mechanical, industrial, and aeronautical engineering; the totals for each group being 20,014, 1828, and 2084, respectively. (There are 7917 junior and senior mechanical engineering students for 1938–1939; as of Feb. 1, 1939, the number of A.S.M.E. student members was 5306.)

Disregarding "unclassified" engineering courses, the next largest groups are electrical engineering with 13,135, chemical engineering with 12,538, and civil engineering with 10,585, respectively.

Purdue University with 3611 students has the largest undergraduate enrollment and is followed by Texas A.&.M. with 2834, Armour Institute with 2699, Illinois with 2509, Michigan with 2058, Georgia Tech with 2018, and N.Y.U. with 2014, respectively.

The enrollment of graduate engineering students in the United States and Canada for 1938–1939, according to figures submitted, was 4652 for the master's degree and 526 for the doctor's degree. For the 1937–1938 school year, the figures were 2924 and 472, respectively. The University of Detroit leads all schools with an enrollment of 702 for the master's degree, which number is exactly equal to the undergraduate enrollment. Other schools with large enrollments are M.I.T. with 341 for master's and 101 for doctor's degrees; Marquette with 438 and 3; Armour Institute with 311 and 5; Brooklyn Polytechnic with 270 and 9; Stevens with 259 and 0; and N.Y.U. with 203 and 0, respectively.

LETTERS AND COMMENT

Brief Articles of Current Interest, Discussion of Papers in Previous Issues

Tooling Automatic Screw Machines

To the Editor:

Mr. Brinkman's paper[1] deals particularly with the use of special tooling as applied to multiple-spindle automatic screw machines, for the purpose of eliminating secondary operations. He cites the value of thoroughly studying individual jobs to insure proper tooling and efficient operation. The writer agrees that each job released for production should be the subject of special study and analysis, and also that special tooling should be used to eliminate secondary operations, wherever it is economically sound to do so.

The author has particularly emphasized the value of special tooling in eliminating secondary operations on parts which are complex in design and held to a close degree of accuracy. It is important that this angle of the problem be given proper consideration. Secondary operations are frequently resorted to on the grounds that the part is too complex to be completed in one operation, or the tolerances too close to be held with special tooling.

The writer would like to emphasize the economic or cost factor as a reason for using this type of tooling. This is really the final reason why expenditures are made for special tooling. It is also the factor which the planning engineer or shop man must use in selling management on the need for the expenditure.

Our experience indicates that as soon as a part is cut off from the bar of stock, the cost of handling the individual pieces increases the cost of manufacturing considerably. This is true, even though the operation to be performed is an extremely simple one, no more complex than removing a burr. A study of our cost files indicates that secondary operations cost from 50 to more than 500 per cent of the primary operation. Despite the simplicity of the secondary operation, the necessity for manually handling the part seriously affects manufacturing cost. This is true whether the part is placed directly in the machine for the secondary operation, or placed in a magazine which is later attached to an automatic machine.

Practically every type of screw-machine operation can be performed on the cut-off end of the part by means of special tools or power-driven attachments. The use of these tools or attachments frequently adds no increase in time to the total time to machine a piece. We have used these attachments for such operations as drilling, counterboring, countersinking, taper reaming, slotting, burring, and shaving cuts on the cut-off end of a part. Of these operations, the shaving cut is the most unusual and the purpose of it is to insure an extremely fine finish. This operation replaced a secondary operation performed on a grinder.

Our experience confirms the necessity for an individual analysis of the tooling requirements for each part to be manufactured. This is true whether a casual examination indicates the possibility of producing the part in one operation, or indicates the need for several operations. It is impossible to insure efficient operation of machine tools without an individual analysis of special tooling requirements. This analysis must be based on the following:

1 Specifications as outlined on part drawing.

2 Manufacturing quantity produced at each setup.

3 Ultimate production or total number of pieces to be produced.

When necessary, as indicated by the design of the part, the analysis should include several methods of manufacturing. For example, making the part complete in one operation, and making the part in several operations. The results of this analysis should then be reduced to a basis of cost per piece. Cost per piece should be the ultimate cost, including the cost of tools. This can readily be computed by dividing the cost of the tools by the expected ultimate quantity of parts to be produced, and adding the answer to the manufacturing cost of the part. The decision as to which method to use then becomes purely an economic one.

A close study of the specifications as outlined on the part drawing will indicate the number of individual cutting tools to be brought into contact with the work, and the arrangement and sequence in which these tools must operate. It will also indicate the operation involving the greatest amount of time and those which will have to be performed after the piece is parted from the bar. Proper consideration of these factors should result in the efficient tooling and handling of the job. If the design of the part is particularly complex and the tolerances exceptionally close, it may be necessary to restrict the number of machines handled by one operator, in an attempt to make the part complete in one operation. This, however, will be immediately reflected in the cost study which will clearly indicate whether or not it is economically practical to consider this method. This question is usually determined entirely by the ultimate quantity of parts to be produced, as an extremely small saving per piece can become an important factor when applied to large-quantity production.

It is important to know the manufacturing quantity to be produced at each machine setup, as this factor determines whether or not it is economical to consider the setup of machines for large-quantity production. This is particularly true where operators act as their own setup men, as long setups on short runs have a material effect in reducing the efficiency of the group as a whole.

Ultimate production is usually the factor which determines whether or not it is advisable to provide the tooling required to eliminate a secondary operation. It is frequently possible to effect a saving of from 50 to 80 per cent of the parts' cost by eliminating secondary operations and still be economically unsound to do so. This is only true, of course, where the cost of the parts does not include the cost of tooling. For example, a year's supply of parts, including secondary operations, may cost $2500. If secondary operations are eliminated, the cost may be reduced to $1250. The cost of tooling, however, may amount to $2000. If the part is to be in production for only a single year, it is obvious that it should be manufactured on the basis of secondary operations, as to make the part complete, including the tools, would cost $3250. If the part has an expected life of two years, then the special tooling, at the cost previously mentioned, should obviously be

[1] "A New Method in Tooling Automatic Screw Machines," by E. W. Brinkman, Mechanical Engineering, September, 1938, p. 666.

provided. On this basis, the ultimate cost of two years' supply of parts, including tool cost, would amount to $4500 instead of $5000.

We were able to accomplish the following yearly savings, as tabulated herewith, by eliminating secondary operations, at the tool costs indicated.

Yearly saving	Tool cost
$1020.76	$ 600.00
7409.72	2200.00
1591.29	900.00
4782.60	1200.00

These figures do not represent the entire saving resulting through the elimination of secondary operations, but are representative of the results which can be accomplished.

In addition to the savings listed, there were additional savings realized through the release for other work of the machines used on the secondary operations.

Some of the special tooling required to eliminate secondary operations is quite flexible in its application to a variety of parts. This is particularly true of attachments required for such operations as drilling, facing, and burring the cut-off end of the part. The expense of this equipment can frequently be justified by grouping the savings on a number of parts.

The use of special tooling and attachments has been thoroughly proved on single-spindle automatic screw machines. In fact, most concerns find it advisable to equip a certain percentage of their machines with one of the more commonly used devices, such as slotting attachments, burring attachments, and so on. It is believed that a similar policy will be used with respect to multispindle machines in the future. In fact this policy is already in effect on some of our smaller sizes of multispindle machines.

W. T. FORDE.[2]

Industrial-Evaporator Design, Application, and Operation

TO THE EDITOR:

It is interesting to note that all five factors which Mr. Adkins has listed as having been considered in connection with the design of the Firestone high-pressure power plant are related to water problems.[3] Until recent years, this phase of power-plant operation had too frequently been given consideration after the plant had been in operation, and serious troubles encountered, rather than at the time the plant was designed. In some cases, costly alterations have been necessary to offset troubles that could have been avoided had the water-conditioning problems been given adequate attention.

Mr. Adkins points out that, at the time of the Firestone installation, experience on treating water for boilers in the range of from 800 to 1400 psi pressure was limited. Since this installation, there has been considerable experience in connection with the use of unevaporated make-up water for high-pressure boilers. In the Pittsburgh district, boilers are operated at 900 lb pressure on 100 per cent make-up of Ohio River water, lime-soda treated, followed by internal conditioning with phosphate. Several plants in the Akron district have boilers operating at from 800 to 900 psi, using from 70 to 80 per cent make-up water, lime-soda treated, followed by internal phosphate conditioning. While it is desirable to use feedwater having low total-solids concentrations, it is not absolutely necessary that this be done. The cost per 1000 lb of steam should be the deciding factor as to whether evaporators should be installed, or whether unevaporated make-up in conjunction with proper water conditioning should be used.

While the problem of preventing deposition in the evaporator heat exchangers has been practically solved by the use of dispersive tannin, it is still necessary to clean these heat exchangers at infrequent intervals, due to the effect of the extremely high temperatures on the dispersive action of tannin. The recently developed "threshold treatment" may improve matters in this respect. The term threshold treatment is applied to the use of sodium hexametaphosphate in an amount so small that it is only on the threshold of water treatment as the problem is generally conceived. The addition of from 1 to 5 ppm of sodium hexametaphosphate to water has a tremendous effect both in preventing the precipitation of calcium carbonate and in removing old carbonate scale from heat-exchange equipment. This effect is produced regardless of the amount of calcium in the water and irrespective of whether the calcium carbonate tends to be precipitated due to the removal of carbon dioxide from the water by driving it off with heat or by the addition of some chemical reagent.

The effect of threshold treatment in preventing deposition in heat-exchange equipment when temperatures are less than 180 F has been demonstrated in a great number of cases. Research is now being conducted to determine whether or not threshold treatment can be applied in cases where the temperature exceeds 180 F.

It is the usual practice in evaporator operation to permit scale to form on the evaporator coils and then remove it by cracking. Whether or not the scale can be efficiently removed from the coils by cracking depends upon the type of scale and its structure. A hard brittle scale, such as calcium sulphate, cracks readily, while a soft adherent scale, such as calcium carbonate, does not. In some cases, the evaporator feedwater has been treated with sulphuric acid to reduce the carbonate concentration, increase the sulphate concentration, and thereby promote deposition of calcium-sulphate scale, which in comparison to calcium-carbonate scale, is readily removed by the cracking process.

In the case of the Firestone evaporators, complete phosphate conditioning has been maintained in the evaporator shell water, thus preventing the formation of scale on the evaporator coils. As pointed out by Mr. Adkins, the scale-free evaporator coils make possible in actual operation a heat-transfer rate through these coils that exceeds the expected rate and approaches the theoretical. It is quite apparent that by maintaining the evaporator coils scale-free the evaporators can be operated at higher efficiency than if the scale were permitted to form on the coils and periodically removed by cracking. This being so, it seems desirable that the problem of water conditioning, as applied to evaporators, should be considered in the design of new evaporator equipment, especially in regard to the type of metal used in the construction of the evaporator coils.

E. W. BUTZLER.[4]

TO THE EDITOR:

Mr. Adkins' paper presents an interesting and instructive treatise on the subject of evaporator design and operation as applied to industrial-plant power and steam supply. The proper conditioning of the water supply to the evaporators and the control of the quality of steam delivered by the evaporators are probably the most important factors in the operation of such equipment and Mr. Adkins has dealt with these subjects in an excellent manner.

One feature of the operation which is not mentioned in his paper is the control of the pressure of the vapor delivered by

[2] Supervisor, Planning Dept., International Business Machines Corporation, Endicott, N. Y., plant.

[3] "Industrial-Evaporator Design, Application, and Operation," by W. K. Adkins, MECHANICAL ENGINEERING, October, 1938, pp. 738–740.

[4] Chemical Engineer, Hall Laboratories, Inc., Pittsburgh, Pa.

the evaporators and its relation to the pressure of the turbine exhaust which is the source of steam to the evaporator coils. In cases where the evaporator installation for supplying process steam is operated in conjunction with boilers operating at the process-steam pressure, the evaporators and back-pressure turbine can, of course, be operated at a fixed load, and back-pressure control is not important. Where the evaporators are the sole source of process steam, the control of the back pressure on the turbine, as to whether it will be from the vapor side of the evaporators or directly at the turbine exhaust, becomes an important problem. Due to the lag between the vapor pressure and the back pressure from the turbine, any individual installation would require a specific study to develop a form of turbine back-pressure control which would result in maintaining a constant evaporator vapor pressure. Although such a scheme of control has not been actually put into effect according to the writer's knowledge, studies have been made which indicate its feasibility. In cases where the conditions warrant its adoption, the necessary equipment should preferably be installed by the turbine manufacturer.

H. J. KLOTZ.[5]

TO THE EDITOR:

In Mr. Butzler's letter he states that, since the Firestone installation, there has been considerable experience in connection with the use of unevaporated make-up water for high-pressure boilers. The 900-psi boiler, mentioned, using 100 per cent make-up of Ohio River water is of the bent-tube type. It requires more space, and is more expensive, but it will operate at higher concentration than the sectional-header type of boiler.

The 800- to 900-psi boilers in the Akron area are either bent-tube type or operate on make-up water which has only about 10 per cent of the total solids contained in the water used in the Firestone evaporators.

Frequently the total solids in the Firestone water supply exceed the total solids which can be carried in the high-pressure boiler. Obviously, in such cases, evaporators are necessary.

The author is of the opinion that water conditioning which is satisfactory for boilers operating at from 800 to 900 psi would not necessarily be satisfactory for boilers operating at from 1200 to 1400 psi.

W. K. ADKINS.[6]

[5] Assistant Chief Power Engineer, Stone & Webster Engineering Corporation, Boston, Mass. Mem. A.S.M.E.

[6] Firestone Tire & Rubber Company, Memphis, Tenn.

The History of Rubber as an Engineering Material

TO THE EDITOR:

In his paper[7] Dr. Geer mentions that standard rubber products can be manufactured "in any desired tonnage." To substantiate this statement, it may be stated that last year 1,092,279 long tons of crude rubber were produced on the plantations, and this is only about two thirds of the potential production. A little over half of the total amount which is produced is imported into the United States. Surely of rubber there is no end.

For some unknown reason vulcanized rubber ages more rapidly when stretched about 8 per cent. This is noticeable, for example, in hose which has been stretched over a coupling. If rubber must be kept in a slightly stretched or bent position it should be molded originally in that shape. That is why the rubber running boards on automobiles are molded instead of being fastened in a bent position.

Ozone is the great enemy of rubber. Its action on unstretched rubber is slow but on rubber under moderate tension its action is rapid. Rubber in the vicinity of a corona discharge should be properly protected with a coating which will withstand the action of ozone.

Some organic accelerators will cause vulcanization of rubber mixes even at room temperatures, and so active are some of them that the batch will vulcanize during the mixing on the mill. In order to take advantage of low-temperature acceleration, the accelerator is sometimes prepared in the mix after it has been fabricated, by painting on its surface a solution of one substance which penetrates the rubber and reacts with another already in the mix. Unvulcanized rubber for certain uses can therefore be shipped long distances or transported even in the heat of summer without danger of being prematurely vulcanized. In this manner rubber which is required for the linings of tanks can be applied and vulcanized in the field far from the rubber factory.

HARRY L. FISHER.[8]

TO THE EDITOR:

Dr. Geer has taken a broad point of view in indicating the fields to which rubber lends itself as an engineering material. I wish to contribute a little more to such a viewpoint.

Those who think that the use of rubber as a load-carrying material is relatively new, should be reminded that rubber springs were used on railroad trucks in this country more than sixty years ago. The trucks of the cars of the train from which Thomas Edison was ejected for causing a conflagration, as a result of his researches into the mysteries of chemistry, were equipped with springs made in the form of rubber cylinders. These

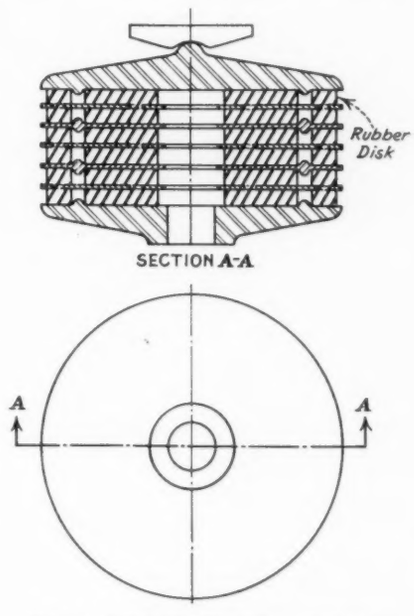


FIG. 1 SPENCER-MOULTON AUXILIARY RAILROAD-TRUCK SPRING

took the full load of the car body, and the design of truck was similar to that used today on passenger trains. As early as 1879 the B. F. Goodrich Company sold rubber-spring cylinders to street-railway companies in this country for taking the full load of the car body at the journals.

The Spencer-Moulton spring shown in Fig. 1 goes back about fifty years These springs were made up of stacks of rubber disks separated by steel washers, were used as auxiliary springs at the ends of leaf springs on railroad locomotives in England and on the Continent, and are still in use quite extensively.

The use of rubber to support automobile engines goes back at least eighteen years, and today, I do not believe any automotive engineer would think of using anything but rubber mountings for supporting the engine. Today, rubber mountings are being scientifically designed to support airplane engines all because of that property which the acoustical engineer chooses to call the compliancy of the material.

Rubber is not the simplest engineering

[7] "The History of Rubber as an Engineering Material," by William C. Geer, MECHANICAL ENGINEERING, September, 1938, pp. 682–685.

[8] U. S. Industrial Alcohol Company, Stamford, Conn.

material in the world with which to work. For instance, we have soft steels and hard steels, but their modulus of elasticity is practically the same. In the case of rubber the modulus of elasticity of hard stock may be six times that for soft stock. There is great difficulty in comparing a hard stock with a soft stock, especially where such properties as permanent set and creep in the structure are to be measured. If we take two disks of rubber 1-in. diam and $^1/_4$-in. thick, one of durometer 40 and the other of durometer 60, and load each between flat steel plates of a set-testing jig for a specified time under 400 psi spring load, the softer rubber will be penalized because of its greater deflection and consequent distortion.

If, however, on the other hand, each sample is deflected the same amount, the harder stock will be penalized because it is under greater stress. For strict comparison it would be better to make the hard sample thick enough so that under a load of 400 psi the percentage deflection would be the same as that of the soft sample.

Errors may also creep into measurements of hardness by use of the conventional surface-hardness instruments such as the Shore durometer and the Pusey &

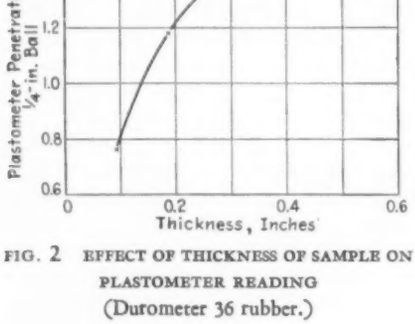


FIG. 2 EFFECT OF THICKNESS OF SAMPLE ON PLASTOMETER READING
(Durometer 36 rubber.)

Jones plastometer. Fig. 2 shows the change in plastometer penetration with a $^1/_4$-in. ball with various thicknesses of rubber of durometer 36. It is apparent that a minimum thickness of $^3/_8$ in. of such soft rubber should be used for accurate plastometer readings.

Fig. 3 shows the relation between plastometer penetration with balls of $^1/_8$ and $^1/_4$-in. diam and readings with the standard type-A Shore durometer. The line is approximately straight from 35 to 60 durometer with the $^1/_8$-in. ball and from 30 to 60 durometer with the $^1/_4$-in. ball.

There is another factor which decidedly affects results; the accuracy of dimensions of test pieces, especially the thickness. In practice it is almost impossible to mold rubber articles with uniform thickness. The variation in thickness of a slab, thicker at one end than at the other, causes serious errors in data when compressed between flat plates in a testing machine. The error becomes tremendous on thin slabs of appreciable area, especially when the rubber is in the upper range of hardness. It is my experience that many of the data submitted on compression slabs and disks have been taken on test samples that did not have perfect parallelism of the loading surfaces. The percentage deflection near the origin, in such cases, will show greater values than would be obtained on true samples.

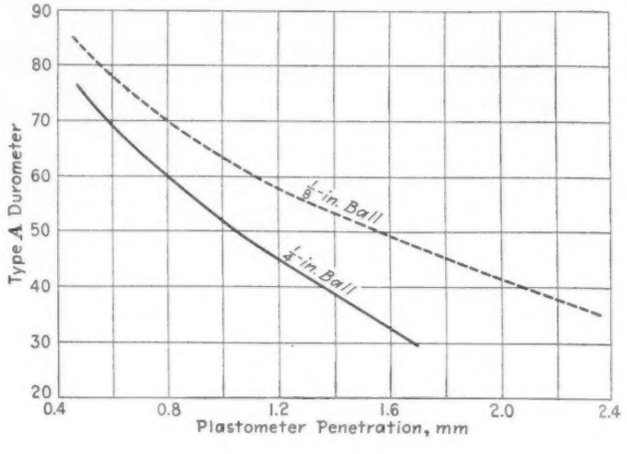


FIG. 3 PLASTOMETER PENETRATION VERSUS READINGS OF DUROMETER TYPE-A

The design of rubber parts for engineering use is not such a guessing proposition as ordinarily supposed. In the past nearly all data submitted on rubber have been by chemists and physicists who wished to prove certain points regarding improvements in the quality of rubber. The time is at hand when data for design purposes will be submitted by engineers more and more often so that rubber will find its true place as an engineering material.

F. L. HAUSHALTER.[9]

TO THE EDITOR:

In connection with Dr. Geer's excellent paper attention should be directed to two publications which may be helpful to the design engineer. One of these is a brief engineering handbook issued by the United States Rubber Products Company under the title, "Some Physical Properties of Rubber." This handbook gives data, formulas, and nomograms in such a form that many problems of design can be handled in the drafting room. The data relate to six typical rubber compounds which cover a range of properties wide enough for most practical requirements. An excellent abstract of this publication is given in Kent's Mechanical Engineers' Handbook, Vol. 3, Design. Shop Practice, eleventh edition, 1938.

The other publication is the monumental work of Dawson and Porritt, entitled "Rubber: Physical and Chemical Properties," published by the Research Association of British Rubber Manufacturers, Croyden, 1935. This book gives, in tabular form, all the reasonably reliable and significant physical measurements on rubber which were published from the beginning of the industry up to 1934. Because of the comprehensive scope of the book it is not directly useful as an engineering handbook, but the engineer who is willing to acquire sufficient background knowledge of rubber technology to select, interpret, and utilize the information intelligently will find it valuable.

A. T. MCPHERSON.[10]

TO THE EDITOR:

Dr. Fisher mentions the rapidity of aging of vulcanized rubber when under tension. This characteristic is one of the unfortunate properties shown by this material. Of interest to engineers is the observation from practice that when vulcanized rubber is flexed repeatedly it retains its characteristics during a longer period of time than when under static tension, which perhaps accounts for the excellent life of rubber blocks when used as springs. Measurements upon sizable pieces should be made in order to learn the precise rate of degradation under each of these conditions.

Because an engineer who would engage in investigations of vulcanized rubber for large-scale uses should know what has been published about the physics of rubber, even though the data were obtained

[9] B. F. Goodrich Company, Akron, Ohio.

[10] Chief, Rubber Section, National Bureau of Standards, Washington, D. C.

from a study of small test sections, he might do well to have at hand, in addition to the references mentioned by Dr. McPherson, the American Chemical Society Monograph No. 74, by Davis and Blake, published in 1937 and entitled, "The Chemistry and Technology of Rubber," and also the several volumes of *Rubber Chemistry and Technology* which is published quarterly under the auspices of the Rubber Division of the American Chemical Society. Even though the word chemistry is used in these titles, these works contain much information of a purely physical character.

Mr. Haushalter mentions only a few of the difficulties connected with the use of rubber upon a large scale. Yet these and probably all of the others can be solved, making vulcanized rubber a thoroughly reliable engineering material if sufficient research work is performed.

Although I agree with Mr. Haushalter in the main, I doubt if any "rubber mountings are being scientifically designed to support airplane engines" or any other machinery. Science infers known relationships which can be applied to new situations. On the other hand I do agree with his closing sentence, but I would describe the present situation about as follows: The design of rubber parts for the support of machinery and other engineering uses can successfully be accomplished only by engineers who are well versed in the chemistry and physics of rubber and who are experienced in the application of vulcanized rubber for engineering uses.

It is not wise procedure for a draftsman to specify in detail what a rubber manufacturer should construct for any proposed new installation, any more than an electrical-power-plant engineer should specify the composition of steel to be used in the tubes of his steam boilers. The engineer naturally should, today and probably always, look to men of such experience and judgment as Mr. Haushalter for the solution of his rubber problems.

The chief point I tried to make in my paper may be summarized again in brief: Although we know a great deal of the science of the chemistry and physics of vulcanized rubber on a small scale and can manufacture uniform blocks of rubber of any desired size and quantity, much research remains to be done. When enough is known of the engineering science of rubber confidence in it will be established, and vulcanized rubber will find extended use in this larger potential field.

WILLIAM C. GEER.[11]

[11] Research Chemist, Ithaca, N. Y.

Recent Developments in Thread-Grinding Practice

TO THE EDITOR:

In this paper,[12] the writer was uncertain as to Mr. Miller's intentions, whether he intended to suggest the finishing of screws on a manufacturing scale by grinding, or simply the production of precision screws by that process. Grinding is a corrective or precision-producing process and could not properly be applied to screws except as a corrective measure. The writer has had occasion recently to confer with the United States Division Officer for the metropolitan district with regard to the production of gages. Mr. Miller's paper brings to mind the great difficulty encountered during the world war in obtaining external and internal thread gages. There was practically no capacity in this country. Every little tool shop in the metropolitan area was called on for the production of this type of gage and had to improvise ways for their production. It is therefore suggested that those concerns which are in the business of making plug and ring cylindrical gages should seriously consider the addition of suitable equipment for this purpose. It would be unfortunate in case of another war if we had to depend on makeshift arrangements for producing these gages which are so essential to the United States government in the production of munitions and ordnance.

ELMER H. NEFF.[13]

TO THE EDITOR:

Mr. Miller's paper, dealing with thread grinding, mentions three types of thread grinders. There are at least two more methods of grinding threads.

Several European thread grinders are on the market, which are equipped to use a multiple-groove wheel which is slightly wider than the length of thread to be ground. This wheel is advanced toward the axis of the work until it reaches the proper depth, at which time the work is revolved and advanced at the proper lead, either once or several times, depending on the finish required, or whether or not the pitch of the grooves in the wheel is the same as that to be cut in the work.

In the case of fine threads the pitch of the wheel groove may be twice or three times that of the pitch of the work. This is done to facilitate the forming of the wheel.

[12] "Recent Developments in Thread-Grinding Practice," by Paul V. Miller, MECHANICAL ENGINEERING, October, 1938, pp. 741–743.

[13] Mechanical Engineer, Brown & Sharpe Mfg. Co. Life Mem. A.S.M.E.

The multiple-groove wheel is formed by running the wheel at a slow speed and pressing a formed roller into it. As may be imagined, the thread groove formed by this wheel is liable to be nowhere nearly as accurate as that formed by the passage of a single wheel.

The fifth method is to form a wide wheel with a thread groove on it, of the same pitch as desired on the work. If both the wheel and the work are turned at the same number of revolutions as they feed toward each other, the proper thread is ground in the work. The results are similar to rolling a thread in a screw machine with a single roll. This thread also cannot be more accurate than the wheel which forms it.

The third type of machine mentioned by Mr. Miller, using a cam or wedge to develop the pitch of the thread has not been so successful in a number of cases, largely because of the use of a worm and worm wheel to secure the reduction between the head spindle and the cam. The contact between these elements is so small that they must be made with exceptional accuracy or lead errors in the form of drunken threads are introduced in the work. Of course as long as threads are measured with ring gages only, this would not be discovered but on tap-and-gage work the operator must be on guard at all times to prevent it.

I believe that, as inspection grows more severe, many more threads will be ground, or many threads now requisitioned as class 3 will be changed to class 2. Consider this: Given a theoretically perfect $^1/_2$–in–20 basic ring gage and a corresponding threaded screw with its pitch diameter 0.0026 in. smaller than the ring gage, which is the limit for class 3. If we plate the screw with a coating 0.00066 in. thick the screw will be too large to enter the ring gage without being forced. Such is the class-3 fit screw and the class-4 fit has just one half the tolerance of the class-3 fit.

Can you believe many screw threads cut with a die are actually within this tolerance? True they will reject the no-go gage but the thread form often has some deformity which could be picked on by a severe inspector. In addition the inspection of a screw thread is comparatively simple but what about the form of thread in the nut?

Certain screw threads should be ground to insure accurate results unless ball-and-socket washers or oversize nuts are used. Many hardened shafts and arbors have caused endless trouble because the thread, although carefully cut when the shaft was soft, was deformed in hardening and a nut, fitting the thread too snugly, cramped and caused the shaft to spring

when tightened. Engineers who believe that class-3 fits are required for such nuts will find that grinding the thread after hardening is the only cure for this ill. Ground threads are particularly desirable on shafts which run at 15,000 rpm or faster as there is much less trouble from lack of balance.

On the smaller diameters in large-quantity production, grinding will probably never take the place of thread rolling, except where exceptional accuracy is required. On many larger jobs, especially where quantities are not great, grinding costs compare favorably with thread milling, if there is enough work to keep the thread grinder busy.

At present, commercial thread grinders are built with the idea that they shall be more or less universal, which runs the cost of the necessarily large machine up quite high. If a demand for grinders for stud work, for instance, is really discovered, undoubtedly a smaller grinder of the single-purpose type will be built.

Mr. Miller refers to larger wheels for the purpose of increasing wheel life between dressings. My experience has been that on hardened parts that have been roughed out before hardening, several passes at a medium rate of speed will finish them quickly without drawing the temper, and allow several to be finished at one dressing of the wheel, but on work ground from the solid, heavy cuts should be taken and the wheel dressed on each piece before the finishing cut is taken. I have recently seen a 1–in–8 thread $1^1/_2$ in. long on a heat-treated shaft finished in two cuts with the wheel dressed between the roughing and finishing cut. The wheel used was a resinol wheel run at a speed of 12,000 fpm on the roughing cut and 9000 fpm on the finishing cut. This speed change is automatically taken care of in the switchboard of the machine. After the setup 15 pieces were completed in 20 min. However the set-up time was about three quarters of an hour.

One consideration entering into the question of the method of thread grinding is what kind of a surface is allowable on the finished thread. Any grinding operation leaves a soft surface, the depth of which is partly determined by the amount of stock removed. If a hard surface is required on the thread the last cut should be light enough to just clean out the work. If, however, the reason for grinding the thread is simply to get a true running surface this condition can be forgotten. It must not be forgotten that the removal of stock by grinding on deep-hardening steels often relieves strains which cause the work to spring. This is especially true when a thread is ground so it is often desirable to rough-grind a shaft, leaving a small amount to be cleaned up on the finish cut.

CHARLES C. WINTER.[14]

TO THE EDITOR:

In Mr. Neff's letter he states that grinding is a corrective or precision-producing process. I think perhaps this statement should be qualified somewhat, as today threads are ground in many cases from the solid, and thread grinding has become a generative process as well as a corrective one. Much of the equipment built today is suitable for this operation, whereas only a few years ago this was not the case.

PAUL V. MILLER.[15]

Industry, Labor, and the Public

TO THE EDITOR:

When considering the problem which faces management and its relations to labor and the public[16] it would seem well to give serious thought to certain things which have happened. In 1933 the Federal Government promised the people it would make all business good. The National Recovery Administration was to be the medium. The blue eagle was adopted as the emblem. Codes were drawn up for all industries and if a businessman did not join up quickly there was to be a cracking-down process.

There was one notable exception in the case of The Ford Motor Company. For decades this company has been selling the public the idea that it paid the highest wages, was the best managed, and gave more consideration to its customers, to labor, and to the public than any other company. There was no cracking down. Mr. Ford had no difficulty in making the people believe that his standards were so high that he would have to lower them to adopt the blue eagle.

Later came the National Labor Board created by the Wagner Act, and the C.I.O. began a remarkable growth in membership. Again, The Ford Motor Company was able to resist coercion efforts which were apparently supported by the government. Unions were not able to gain control of his labor.

The point is that there are other manufacturers in this country who pay high wages, who treat labor well, and whose plants are well managed. The fact, however, is that the public does not know as much about them. The Ford Motor Company has sold its management as well as its product to the public. The test it has stood during the last six years would indicate the advantage of doing this on the part of every manufacturer.

J. E. BULLARD.[17]

TO THE EDITOR:

Employers, particularly manufacturers, are inclined to devote their major energies to the development of sales and to the perfection of manufacturing processes. Most of the labor problems which have been encountered in recent years could have been avoided had those employers devoted the same kind of energy to their wage earners and their needs, either actual or imagined. Too frequently, the employer has been content to leave all such problems entirely in the hands of an employment manager. In the light of the happenings of recent years, labor relations deserve the same kind of executive thought and energy as do sales and production.

WARNER SEELY.[18]

TO THE EDITOR:

I am glad to see the comments on my paper. You will be interested to hear that I have received a large number of similar letters, some of them from prominent executives. Practically all of those from whom I have heard have endorsed this statement of relations as sound and fundamental. Some even suggested that it might be amplified in certain directions as an aid to the development of better understanding of these fundamentals and of the importance of their application.

Naturally, I cannot help but feel pleased with this rather generous response. My purpose in preparing the article was to present, if possible, a statement of the fundamentals of sound relations among management, workers, customers, stockholders, and the communities of which all are members.

It has been suggested to me that this statement can be useful as a minimum code of these relations. The chief executive of an internationally known manufacturing company said that he was checking his company's relations in these several respects, using my statement as a yardstick.

If the Management Division of the

[14] Winter Bros. Co., Wrentham, Mass.

[15] Manager, Small Tool Division, The Taft-Peirce Manufacturing Company, Woonsocket, R. I. Mem. A.S.M.E.

[16] "Industry, Labor, and the Public," by R. M. Hudson, MECHANICAL ENGINEERING, August, 1938, p. 613.

[17] Technical and Business Writer, Central Valley, N. Y. Associate A.S.M.E.

[18] Secretary, The Warner & Swasey Co., Cleveland, Ohio. Associate A.S.M.E.

A.S.M.E. wishes to make further use of the article as a "suggested minimum" code in the field covered, I shall be glad to have it do so. There is, unquestionably, a need for something of this kind. The response shows that there is a real demand for it. In this fact, there lies an opportunity for the A.S.M.E. to make a further contribution in the field of social engineering.

R. M. HUDSON.[19]

Motor Drives and Electric Controls on Machine Tools

TO THE EDITOR:

The electrification of machinery has advanced rapidly in recent years due to the development and use of electrical control equipment as distinguished from ordinary motor starters. The machine-tool industry presents many varied problems in machinery electrification and we are indeed indebted to Mr. Graves for his comprehensive paper[20] on this subject. His paper is particularly timely because it not only points out the advantages but also illustrates the proper applications of the various types of equipment.

In discussing the advantages of electric drives, I would like to know more about Mr. Graves' experience covering the cost of such drives. The cost factor is an important item in machine-tool drives since the electrical equipment must be purchased. Electrical reversing and electrical braking are obtainable at a moderate first cost and the maintenance cost is considerably lower than the upkeep of mechanical friction clutches and brakes. In many cases, the simple means of electric reversing and braking cost less than the mechanical equivalent, an additional advantage to those of ease of control, flexibility, and safety as pointed out by Mr. Graves.

The relative costs of electrical and hydraulic drives is a subject too large for this short discussion, but a general rule might be that hydraulic drives for reciprocating movements of low power and wide speed range are simpler and cost less than the corresponding electrical drive. For rotating drives, electrical speed control is generally the most economical. In most instances, electrical control of hydraulic motion will be found the most practical.

Built-in motors are usually more costly to buy and apply than standard motors and I favor standard motors included within the lines of the machine or covers as against the built-in shell type of motor. Customer preference still seems to be for the standard motor as applied to machine tools. However, I agree with Mr. Graves that control items should be built in if possible.

To bring this general discussion to a close, I submit the accompanying example of the advantages of building electrical equipment as an integral part of the machine. Fig. 4 shows a ball-bearing-race grinder, and Fig. 5 a new design. The new design has the electrical equipment built-in, using standard motors protected by machine doors and covers, rather than the totally enclosed and fan-cooled motors on the old machine, thus showing a reduction in the cost of the motors. The additional control features to obtain an automatic cycle on the new machine have added to the control cost but the savings in motor costs have enabled the total net cost of electrical equipment on the two machines to remain about the same. The built-in electrical equipment shows a reduction in the cost of wiring the machine, as the wiring time on the new machine is only 20 hours as compared with 34 hours on the old machine.

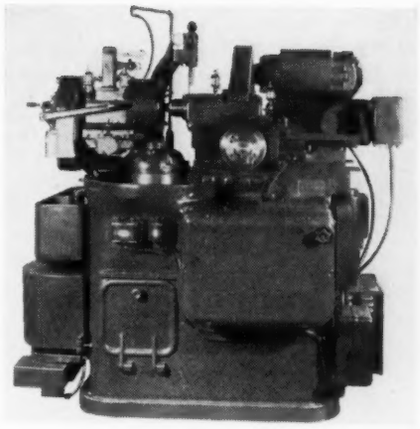


FIG. 4 BALL-BEARING-RACE GRINDER, OLD MODEL

FIG. 5 BALL-BEARING-RACE GRINDER, NEW MODEL

The careful application of electric drives to machine tools is a relatively new development and will probably proceed at a faster rate now that the initial impetus has been obtained. Manufacturers of electrical equipment have shown a fine spirit of cooperation and I believe with Mr. Graves that the next decade will probably show rapid progress in the field of machine-tool electrification.

R. S. ELBERTY.[21]

TO THE EDITOR:

The author has clearly explained the application of electric motors and controls to a number of the smaller machine tools. The principles which he applied can be and are applied to larger machines. Many cases could be cited. For example:

Ten years ago Wm. Sellers & Co., Inc., built two four-head planer-type milling machines with nine motors each. Since the various motors were interlocked a brief description might be of interest.

As these were four-head milling machines, four of the motors were for the

[19] Industrial Executive, New England Council, Boston, Mass. Mem. A.S.M.E.

[20] "Motor Drives and Electric Controls on Machine Tools," by B. P. Graves, MECHANICAL ENGINEERING, October, 1938, pp. 729–734.

[21] Electrical Engineer, Landis Tool Company, Waynesboro, Pa.

spindles, with one mounted on each head. Another motor was mounted on the floor at the rear of the right-hand upright and took care of table feed and rapid traverse. This was a four-to-one adjustable-speed d-c motor which, with one feed-gear change, gave a range of sixteen to one for feed. A gear for rapid traverse gave 60 times the feed. This made the traverse speed from 5 to 20 fpm depending upon the rheostat setting. Another four-to-one motor on the floor beside the right-hand upright took care of head feed, that is, the rail heads along the rail and the side heads up and down on the uprights. Another motor located on top of the crossgirt was used for moving the rail up or down and for traverse of the heads. The other two motors drove pumps, one for the lubrication of the tableways and one for the coolant. All motors were for direct current.

The two feed motors were provided with dynamic braking while the cutter motors were not. This insured the feed motors' stopping before the cutters when both were shut off simultaneously. An interlock was provided so that the feed motors could never be started unless one or more of the cutter motors was running. This was, of course, to prevent the operator from starting the feed without having the cutters rotating. The interlock also worked to stop the feed motors should any of the cutter motors stop through overload or any other cause.

An interesting feature was a table-feed slow-down feature. Whenever one of the cutter motors became loaded to 120 per cent of full load, the table-feed motor was given full field current slowing it down. As soon as the load on the cutter motor eased, the feed motor would pick up its speed again. The result of this was that even if the operator set the machine for too much feed, the cutter motors were protected and the resultant feed was all that was practical to obtain.

The oil-pump motor was connected into the line so that nothing on the machine could be started until it was running to insure oil on the ways and feed-gear mechanism.

The lifting motor was interlocked with the crossrail clamps so that there would be no danger of attempting to move the rail until the clamps were released.

Large machine tools have several points of difference from small ones. In the first place not as many large machines are built which gives less incentive to the electrical companies to standardize the control. Secondly, the control parts are heavier and bulkier and in spite of the larger size of the machines it is more difficult to build the control into the machine parts. Take for instance a large planer. The only suitable place for the control is in the uprights. To place all of it, including the auxiliary control, would necessitate the opening of the uprights from top to bottom and the strength, which is so essential in these members, would be jeopardized. The other alternative is to make the control smaller and lighter and that does not seem practical as planer control is none too sturdy, at least on constant-voltage outfits. Variable-voltage equipment can be lighter and may be the solution although the expense has held this type back in the American market so far.

Another difficulty frequently found with the large machines is in the customer's insisting on furnishing the electrical equipment. How can the machine-tool manufacturer build in the control as the author suggests if many of the customers want to provide the equipment to suit their own standards? The companies that make such demands are usually the larger ones that have their own important electrical departments for maintenance.

This qualification makes no end of trouble for the machine-tool builder. Oftentimes he doesn't know what electrical equipment he is going to get until it arrives in his plant probably long after the machine is assembled and waiting. Sometimes, due to misunderstanding between departments in the customer's plant, there are errors in the specifications and further delays are encountered while they are straightened out. We have known of several cases where the customer supplied the main motor and control and ignored the machine-tool builders' specifications of interlocks, for the auxiliary equipment. Then too, it is bad to have divided responsibility for the electrical equipment, where some is furnished by one company and the rest by another.

The writer wishes to register a plea that machine-tool manufacturers always be allowed to furnish the electrical equipment and install it on the machines before shipment. In the long run this will be more satisfactory to the customer and the builder. The way to insure this is perhaps to have all machine-tool builders get together and agree that on certain types of tools, they would always furnish the electrical equipment and ask the customer's cooperation.

COLEMAN SELLERS, 3RD.[22]

TO THE EDITOR:

In reading over the comments by Mr. Elberty and Mr. Sellers, it seems that both are in accord with the general thought of the paper. Mr. Elberty says that he is interested in knowing more about our experience covering the cost of these drives. We realized at the start that this would be a serious factor because practically all the equipment used would have to be purchased outside which would take considerable work out of our own factory. But after a careful analysis in many cases we prepared designs for three different methods, namely, mechanical-electrical, hydraulic-electrical, and all-electric. In the cases of all-electric machines that were built by us, it has been by choice, both from the performance and cost standpoints.

Lately I have had the privilege of seeing many new designs of the all-electric machines which have proved to be economical and at the same time much more versatile than the previous design which was strictly mechanical. We have been dealing with this electric problem for so long that we can very quickly determine at the start the design which is going to be the most economical. This is accomplished by complete coordination between our machine designers and our electrical engineers, this study of course being performed before much designing is done.

In connection with Mr. Sellers' discussion, I recall seeing these two four-head planer-type milling machines while under construction at the Sellers plant, and it is just another case which proves that much can be accomplished by using the natural functions found in electric motors and controls.

Mr. Sellers states that locating controls is much more difficult on large machines, whereas we feel that our problem is much more difficult when in enclosing all the controls in the machine proper when the machines are of rather small dimensions and have so many different functions operated electrically. However, here again, it is surprising how much can be accomplished along this line by careful study and coordination between the designer and electrical engineer.

Mr. Sellers' plea that machine-tool manufacturers always be allowed to furnish the electrical equipment and install it on the machine before shipment is a point well taken. However, we have encountered very little trouble when the customer insists on our using equipment that he furnishes. It is one of the points in our design that we strive for, not to put too much limitation on the type or make of electrical equipment that can be used.

B. P. GRAVES.[23]

[22] Research Engineer, Wm. Sellers & Co., Inc., Philadelphia, Pa. Mem. A.S.M.E.

[23] Director of Design, Brown & Sharpe Mfg. Co., Providence, R. I.

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

Steam-Boiler Plant

DIE DAMPFKESSEL. By Dr.-Ing. A. Loschge, Professor, Technical High School, Munchen. Julius Springer, Berlin, 1937. Cloth, 6 × 9 in., viii and 424 pp., 343 figs., 38 tables, 24 rm.

REVIEWED BY A. G. CHRISTIE[1]

MANY YEARS ago textbooks on steam boilers were published in this country by Kent and by Miller. These naturally dealt with earlier types of boilers and are now largely out of date. At other times, commercial concerns have issued extensive treatises dealing with the principles and construction of the Stirling, Heine, Kidwell, Babcock and Wilcox, and other types of boilers and their accompanying equipment. Boiler plant has been considered to a greater or less extent by the authors of recent books upon steam-power plants. No book dealing exhaustively with boilers and their auxiliary equipment has appeared in English in recent years. Professor Loschge's book, therefore, has a special appeal as a comprehensive discussion of this important element in power generation.

This lack of American leadership in presenting theory and practice of boiler plants is particularly puzzling when one considers that the engineers of this country pioneered in most of the outstanding developments of this equipment. Among these would be included the sectional header water-tube boiler, the underfeed stoker, pulverized-coal machinery and methods, waterwalls for furnaces, slag-tap furnace bottoms, large-output boilers, boiler-control systems, and many of the auxiliary instruments. Probably our operating engineers have been interested only in over-all performances and not in the heat-transfer factors of individual items, which problems have been left to the boiler manufacturers. Or possibly some American author has a classic text under preparation.

Professor Loschge's book serves also as the eighth completely revised edition of the earlier text by Tetzner-Heinrich on "Die Dampfkessel." It is suited for use both as a student's textbook and as an aid to the practicing engineer. The book considers the complete "boiler plant" for it deals with each step from fuels and their combustion to the provision of draft at the stack. The author has availed himself of many German data and at the same time quotes frequently from American practice, with which he appears to be familiar.

The first section deals with theoretical considerations. Properties of steam are briefly stated. Fuels and their combustion are discussed quite fully, with special attention to heating values and to methods of calculating air and flue-gas quantities, without and with excess air. The author gives Rosin and Fehling's approximate gas equations and shows also graphical methods of presenting flue-gas data. The author discusses the calculation of heat quantities at various temperatures of the products of combustion and presents a graphical method of showing these values on an enthalpy-temperature diagram, which is useful in boiler calculations and design. The application of the principles of heat transfer to all portions of the boiler plant is discussed in an excellent manner and workable formulas are given based upon experimental values both for convection and radiant transfer. The author emphasizes that both convection and radiant transfer must be considered with all hot gases. He also points out that convection transfer rates can be improved by increasing the heat-transfer coefficient on the gas side of the surface.

The second section deals with furnaces and is largely descriptive. Hand-fired and sloping grates and stokers, many of which have no American counterparts, are discussed at length, while the underfeed stoker is only briefly described. The older Lopulco powdered-coal systems only are discussed at some length, as the newer American systems are not yet in use in Germany. Much consideration is given to the combustion process and particularly to ignition, which is naturally more difficult with the high moisture German brown coals than with most American coals. The influence of air preheat, air mixing, and turbulence on ignition is given much space. Also the action of water vapor on the combustion process as a catalyzer is discussed. Considerable data obtained from German research on furnaces are given in this section of the book.

The third section considers the steam generator itself. Types of internal furnace, locomotive, fire-tube, water-tube, waterwalls, marine, and special designs are described. Both German and American boilers of recent design are presented with short discussions. Convection and radiant superheaters, various types of economizers, and the several forms of air heaters are analyzed. The author discusses at length the heat-transfer processes in these portions of the plant and indicates how these factors are employed in design calculations. This, together with the earlier section on heat transfer, forms some of the more valuable portions of the book. There is frequent reference in this section to the methods and data developed by Munzinger in "Dampfkraft," particularly with reference to water-cooled furnace walls as well as to the boiler proper. Boiler efficiency is found by difference after the various losses have been determined or estimated from experience. Methods of estimating draft requirements are presented. Much consideration is given to water circulation in the steam generator, particularly with high pressure. The problem of the so-called "neutral" tube is analyzed and the advantages of unheated "downcomer" tubes for all high-pressure boilers are presented. The section on boiler materials and construction details naturally refers to German standardization rules and to German types of safety valves, water glasses, etc.

The fourth section presents in an excellent manner the application of the theory in earlier sections to the design of (*a*) a modern pulverized coal-fired water-tube boiler with extensive waterwalls, and with superheater, economizer, and air heater, and (*b*) a German design of internal furnace boiler. This, together with several examples of calculation methods in other parts of the book, will prove extremely helpful to students of the subject.

The reviewer considers Professor Loschge's book as the most logical and complete discussion of boiler plant that has appeared since Munsinger's texts. Any who can read German will find much of value from a study of this work.

[1] Professor of Mechanical Engineering, The Johns Hopkins University. President A.S.M.E.

Books Received in Library

A.M. FUEL SYSTEM FOR AIRCRAFT. By B. Demtchenko, with an introduction by P. Dumanois; translated from the French by M. E. Boname. Gauthier-Villars, Paris, 1938. Cloth, 6 × 10 in., 231 pp., illus., diagrams, charts, tables, 90 fr. A translation from the French, this book discusses the general technique of feeding an engine, the layout of a fuel system including installation rules, the factors influencing the flow of fuel, mechanical and gravity-feed systems, and the calculation of the efficiency of a fuel system. Several chapters are devoted to diagrams of fuel systems for various hypothetical cases.

A.S.T.M. STANDARDS ON COAL AND COKE, prepared by Committee D-5 on Coal and Coke. American Society for Testing Materials, Philadelphia, 1938. Paper, 6 × 9 in., 152 pp., illus., diagrams, charts, tables, $1.25. Standards and specifications, as developed by the special committee on coal and coke, covering sampling methods, chemical analysis, methods of testing, coal classification, and definitions of terms, are here brought together in convenient form.

AMERIKANISCHE KÄLTETECHNIK, Zweiter Bericht. By R. Plank. V.D.I. Verlag, Berlin, 1938. Cloth, 6 × 8 in., 110 pp., illus., diagrams, charts, tables, 12 rm. In 1929 Dr. Plank published a survey of American refrigerating practice, based upon a visit to this country. The present work, based upon two later tours of inspection aims to inform German engineers about American developments in the construction of large refrigerating equipment during the last decade. The report gives a good survey of the current situation. The applications of refrigeration and household equipment are not considered.

CLAUS KRÖNCKE als Beispiel der Ingenieurausbildung gegen Ende des 18. Jahrhunderts im Gegensatz zur heutigen Berufsausbildung des Bauingenieurs. By W. Sbrzesny. V.D.I. Verlag, Berlin, 1938. Paper, 6 × 8 in., 46 pp., 2.50 rm. Taking as an example a well-known but not unusually eminent engineer of the early nineteenth century, the author presents an account of his life in which special attention is given to his education for the profession. The pamphlet is an interesting contribution to the history of engineering education.

DANIEL WILLARD RIDES THE LINE, the Story of a Great Railroad Man. By E. Hungerford. G. P. Putnam's Sons, New York, 1938. Cloth, 6 × 9 in., 301 pp., illus., $3.50. Engine driver, superintendent, vice-president, president: This is the story of a man who not only left the impress of his personality on every railroad that he was connected with, but also played an important part in the general railroad and labor situation of the whole country.

DAVISON'S TEXTILE CATALOGUES AND BUYER'S GUIDE, 1938 edition. Davison Publishing Co., Ridgewood, N. J. Cloth, 9 × 12 in., 366 pp., illus., free to all textile-manufacturing plants, $12 to others. Brief catalogs of manufacturers who serve the textile industry are grouped in fifteen sections, loosely classified according to use. The "Buyer's Guide" is an alphabetical list covering machinery, raw materials, etc., with an alphabetical arrangement of companies under each heading, a difference in type style indicating those represented in this book by a catalog.

DEUTSCHE KRAFTFAHRTFORSCHUNG im Auftrag des Reichs-Verkehrsministeriums. V.D.I. Verlag, Berlin, 1938. Paper, 8 × 12 in., illus., diagrams, charts, tables. Heft 13: Bremswerkuntersuchungen am Kraftfahrzeug, by H. Klaue. 26 pp., 2.85 rm. Heft 17: Einfluss der Destillationsbedingungen auf die Zündwilligkeit von Dieselkraftstoffen aus Braunkohlenschwelteeren, by R. Heinze and K. Schneider. 20 pp., 2.10 rm. Two publications of the German automotive research organization: No. 13, investigations on motor-vehicle brakes; No. 17, the influence of distillation conditions on the ease of ignition of Diesel fuels from tar-rich lignites.

DIFFERENTIAL- UND INTEGRALRECHNUNG, 3 volumes. (Göschens Lehrbücherei, Bd. 24, 25, and 26.) By O. Haupt and G. Aumann. Walter de Gruyter & Co., Berlin, 1938. Cloth, 6 × 9 in., diagrams, tables. Vol. 1, 196 pp., 11.20 rm; Vol. 2, 168 pp., 9.80 rm; Vol. 3, 183 pp., 10.60 rm. Of the three volumes in this set, the first provides an introductory discussion of series and real functions of one or more variables. The second covers the differential calculus of functions of one or more variables, including both theoretical discussion and applications. In the third, the major portion, on the theory and applications of integrals, is preceded by an introduction to the theory of measurement.

DIE DRAHTSEILE IN DER PRAXIS. By R. Meebold. Julius Springer, Berlin, 1938. Paper, 6 × 9 in., 68 pp., illus., diagrams, charts, tables, 6.60 rm. This brief treatise on wire rope is divided into two sections: The first covers calculations, raw materials, arrangement of the wires, selection of cables, and the importance of the use with respect to cable requirements; the second discusses such phases of use as the effect of conditions on durability, general considerations on wear, sagging, breaks, etc., and a brief chapter on corrosion and its prevention.

Eidgenössische Materialprüfungs- und Versuchsanstalt für Industrie, Bauwesen und Gewerbe, Zürich. Diskussionsbericht Nr. 117, BAUSTAHL ST 52, by T. Wyss. Laboratoire Fédéral d'Essai des Matériaux et Institut de Recherches, Zürich, 1938. Paper, 8 × 12 in., 39 pp., illus., diagrams, charts, tables. This report covers an investigation of the properties of various high-grade structural steels. The investigation covered the general chemical and physical properties and also the effects of various thermal and mechanical treatments and of welding, riveting, etc.

Eidgenössische Materialprüfungs- und Versuchsanstalt für Industrie, Bauwesen und Gewerbe, Zürich, Bericht Nr. 118. ENTWICKLUNG UND HEUTIGER STAND DER PHOTOELASTIZITÄT UND DER PHOTOPLASTIZITÄT im Rahmen der Gesamt-Experimentalelastizität, by R. V. Baud. Eidgenössische Materialprüfungs-, etc., Zürich, 1938. Paper, 8 × 12 in., 23 pp., illus., diagrams, charts, tables. A report of the Swiss federal testing laboratory on the development and present position of photoelasticity and photoplasticity with respect to the whole field of experimental elasticity.

EIGNUNG VON ROHRLEITUNGEN IM KRAFT- UND WÄRMEBETRIEB, edited by der Arbeitsgemeinschaft Deutscher Kraft- und Wärmeingenieure (ADK) des V.D.I. V.D.I. Verlag, Berlin, 1938. Paper, 6 × 8 in., 164 pp., illus., diagrams, charts, tables, 9.50 rm. A compilation of articles by various men upon piping for heat and power work which covers the fundamentals of layout and erection, kinds of pipe, pipe connections and supports, and regulatory and measuring apparatus. A list of German pipe standards is appended.

DIE ELEKTROLYTISCHE OXYDATION DES ALUMINIUMS UND SEINER LEGIERUNGEN, Grundlagen und Richtlinien für die praktische Durchführung der Eloxalverfahren. (Technische Fortschrittsberichte, Bd. 42, 1938.) By A. Jenny. Dresden and Leipzig, Verlag von Theodor Steinkopff, 1938. Paper, 6 × 9 in., 224 pp., illus., diagrams, charts, tables, 10.50 rm. The purpose of this work is to give a general account of current methods of protecting aluminum and its alloys from corrosion. The text is divided into two sections. The first surveys the electrochemical reactions involved, the reactions of aluminum when exposed to gases, and the anodic phenomena at metal electrodes. The second section is concerned with the protective film, the chemical reactions at the electrodes and in the bath, bath control, and the technique of the eloxal process. A chapter is devoted to chemical processes of protection.

ENGINEERING APPLICATIONS OF AERIAL AND TERRESTRIAL PHOTOGRAMMETRY. By B. B. Talley. Pitman Publishing Corporation, New York and Chicago, 1938. Cloth, 6 × 9 in., 612 pp., illus., diagrams, charts, tables, $10. Photogrammetry, the science of measurements from photographs, is treated with the full detail merited by its increasing importance. Photographic fundamentals, types of equipment, aerial photography, stereoscopy, and map projections are discussed. The various methods of photographic mapping, their uses, and the special instruments required are fully described with a wealth of useful illustrations.

FORGING PRACTICE. By C. G. Johnson. Chicago, American Technical Society, 1938. Cloth, 6 × 9 in., 136 pp., illus., diagrams, charts, tables, $1.50. A practical elementary text on hand forging of wrought iron, machine steel, and tool steel; drop forging; and heat-treatment of steel, including annealing, hardening, and tempering.

Forschungshefte aus dem GEBIETE DES STAHLBAUES, edited by Deutscher Stahlbau-Verband. Heft 1: DIE STABILITÄT DES MEHRFELDRIGEN ELASTISCH GESTÜTZTEN STABES. By A. Schleusner. Julius Springer, Berlin, 1938. Paper, 8 × 11 in., 65 pp., illus., diagrams, charts, tables, 4.80 rm. Mathematical analysis of a beam elastically supported at intervals, including subsidiary and characteristic functions. Bending curves and limits under varying conditions of beam strength and supporting power are considered.

FOUNDRY WORK. By W. C. Stimpson and B. L. Gray, revised by J. Grennan. American Technical Society, Chicago, 1939. Cloth, 6 × 9 in., 216 pp., illus., diagrams, charts, tables, $2. A practical handbook on standard foundry practice, including hand and machine molding with typical problems, tools and equipment, casting operations, melting and pouring equipment, and the metallurgy of cast metals.

Great Britain. Dept. of Scientific and Industrial Research. FUEL RESEARCH Technical Paper No. 48. THE HYDROGENATION-CRACKING OF TARS. Part IV, by H. E. Newall. His Majesty's Stationery Office, London, 1938. Paper, 6 × 10 in., 55 pp., illus., diagrams, charts, tables (obtainable from British Library of Information, New York, $0.40). Part IV of a series on the hydrogenation-cracking of tars, this publication describes experiments on the conversion of low-temperature tar acids into aromatic hydrocarbons by treatment with hydrogen at atmospheric pressure. The design and operation of a small-scale plant are included.

GRUNDLAGEN DER ATOMPHYSIK. By H. A. Bauer. Julius Springer, Vienna, 1938. Paper, 5 × 8 in., 249 pp., illus., diagrams, charts, tables, 12.60 rm. A discussion of the development and present status of atomic physics, considered under the three main headings: Particle structure of matter; wave structure of matter; and the combination wave-corpuscular theory. Covers various electronic units, light quanta, and other discrete particles, wave and ray phenomena, and the hypothetical atoms of Bohr, Schrödinger, and others.

GYROSCOPE: Its Practical Construction and Application. By P. P. Schilovsky, with preface by C. V. Boys. E. & F. N. Spon, London; Chemical Publishing Co., New York, 1938. Cloth, 6 × 9 in., 224 pp., illus., diagrams, charts, tables, $3.50. A reissue of a book which appeared originally in 1924, treating of the physics and experimental mechanics of the gyroscope, and explaining its application to the stabilization of monorailways, ships, aeroplanes, marine guns, etc.

HANDBOOK OF REFRIGERATING ENGINEERING. By W. R. Woolrich. D. Van Nostrand Co., New York, 1938. Cloth, 5 × 7 in., 425 pp., diagrams, charts, tables, $5. Information concerning all phases of the refrigeration field for the use of those desiring to take up or now engaged in that work. Covers fundamental definitions and thermodynamic principles, refrigerants, systems and equipment, air cooling and conditioning, preservation of foodstuffs, and special units.

DIE HÜTTENWERKSANLAGEN, Bd. 1. Anlagen zur Gewinnung und Erzeugung der Werkstoffe. By H. Hoff and H. Netz. Julius Springer, Berlin, 1938. Cloth, 8 × 11 in., 468 pp., illus., diagrams, charts, tables, 66 rm. This is a useful book which gives a comprehensive account with considerable detail of the methods and equipment used in metallurgical works and the other industrial plants, such as glassworks and brickworks, where the problem is essentially that of converting raw materials into useful products through large amounts of heat. A great deal of space is given to furnaces and methods of heating. The preparation of fuels and ores, iron smelting and steel making, the smelting of nonferrous metals, foundry equipment, lime and cement burning, ceramic factories, and glassworks are discussed. Metallurgists and mechanical engineers will find the book of interest. There is a bibliography, confined almost exclusively to German publications.

LABORATORIUMSBUCH FÜR GASWERKE UND GASBETRIEBE ALLER ART. 1. Teil: Untersuchung fester und flüssiger Stoffe. By F. Schuster. Halle (Saale), Wilhelm Knapp, 1937. Paper and bound, 7 × 9 in., 168 pp., illus., diagrams, charts, tables. Paper, 8.70 rm; bound, 9.60 rm (price in U. S.). This section of a large series on laboratory-research methods in the chemical and allied industries covers procedures for the examination of solid and liquid materials in connection with gasworks and gas apparatus of all kinds.

MACRAE'S BLUE BOOK and Hendrick's Commercial Register. Forty-sixth Annual Edition, 1938–1939. MacRae's Blue Book Co., New York and Chicago, 1938. Cloth, 8 × 11 in., 3604 pp., illus., $15. The forty-sixth annual issue of this well-known directory follows the established pattern, but has been thoroughly brought up to date. It provides an index of manufacturers and wholesalers and their local distributors, with addresses; a carefully indexed classified list of manufacturers; a directory of commercial bodies, banks, railroads and warehouses in towns of one thousand or more population; and a list of trade names.

MANAGEMENT OF LABOR RELATIONS. By G. S. Watkins and P. A. Dodd. McGraw-Hill Book Co., New York and London, 1938. Cloth, 6 × 9 in., 780 pp., diagrams, charts, tables, $4. The subjects considered in the six parts of this book are as follows: The nature and development of personnel and labor relations, and the general functions of personnel management; psychological aspects of labor relations; technique of selection and placement, including job analysis and intelligence and ability tests; labor turnover, attendance problems, transfers and promotions, incentives, executive training, and health and disability problems; civil-service personnel; employee representation, collective bargaining, and unions.

MECHANICS FOR ENGINEERING STUDENTS. By J. E. Younger. International Textbook Co., Scranton, Pa., 1938. Leather, 5 × 9 in., 461 pp., diagrams, charts, tables, $3.50. A text arranged for courses in analytic mechanics and designed to give only the necessary basic methods prerequisite for advanced engineering courses. The five parts cover, respectively: statics, kinematics, dynamics of rigid bodies, methods of momentum and energy, and the method of dimensions (including use of models). There are numerous problems.

MITTEILUNGEN AUS DEN FORSCHUNGSANSTALTEN, Bd. 6, Heft 8, Sept., 1938. Berlin, V.D.I. Verlag. Paper, 8 × 12 in., pp. 195–224, inclusive, illus., diagrams, charts, tables, 3.40 rm (2.55 rm in U. S.). Contains three articles, as follows: Investigations of the stresses in cable drums for cranes and windlasses; modern valve gears for steam locomotives; and the transformation catalysis of silicic acid in firing silica.

NATIONAL ASSOCIATION OF RAILROAD AND UTILITIES COMMISSIONERS. Report of Special Committee on Depreciation, submitted to the National Association of Railroad and Utilities Commissioners at its Fiftieth Annual Convention in New Orleans, La., Nov. 15–18, 1938. State Law Reporting Co., New York, 1938. Paper, 6 × 9 in., 85 pp., charts, tables, $1.50. This report contains an analysis of the results of accounting for depreciation by both the straight-line and the sinking-fund methods, and also an explanation of various methods of estimating depreciation rates, including the forecast method, turnover method, and actuarial method.

OXYACETYLENE WELDING. By R. J. Kehl, revised by M. H. Potter. American Technical Society, Chicago, 1939. Cloth, 6 × 9 in., 130 pp., illus., diagrams, tables, $1.25. A practical elementary text dealing with the equipment and technique of oxyacetylene welding as applied to different metals and under varying conditions. Certain special applications of the equipment, as for soldering, cutting, etc., are also discussed.

PUBLIC UTILITY RATE MAKING AND THE PRICE LEVEL. By E. M. Bernstein. University of North Carolina Press, Chapel Hill, N. C., 1937. Cloth, 6 × 9 in., 142 pp., tables, $2.50. The purpose of this study is to show how the rate-making rule and its procedure were developed, to consider the difficulties experienced under this rule, to discuss the new methods of rate making that commissions used during the period of rapid fluctuation in prices, and to offer a reasonable solution for the problem of rate making.

RIGHT WAGES AND ABUNDANCE. By A. G. McGregor. E. P. Dutton & Co., New York, 1938. Cloth, 6 × 8 in., 316 pp., $2.50. Discusses production and consumption capacities, wages, and prices, with particular reference to their interrelation. The economic policies of Great Britain and the United States since the World War are examined, and the adjusting of bank credits, exchange policies, and trade factors for the establishment of international amity are considered.

SCIENCE MUSEUM, South Kensington, London. Handbook of the Collections Illustrating MARINE ENGINES. Part 2, Descriptive Catalogue, by H. P. Spratt. His Majesty's Stationery Office, London, 1938. Paper, 6 × 10 in., 132 pp., illus., tables, 2s 6d, plus postage. This volume, which is part two of the Handbook on the history and development of marine engineering, contains more detailed descriptions of the collections of the Science Museum relating to marine engines and boilers, marine propellers, and auxiliary machinery. Each of its ten chapters has an introductory note and detailed technical descriptions of the exhibits, as well as photographs of the more important ones.

TEXTBOOK OF APPLIED HYDRAULICS. By H. Addison. Second edition, revised and enlarged. John Wiley & Sons, New York, 1938. Cloth, 6 × 9 in., 435 pp., illus., diagrams, charts, tables, $5.50. A compact summary of the fundamental principles of hydraulics, and of the manner in which they are applied by the engineer. The book is intended particularly for readers, such as electrical engineers, whose work is not directly connected with hydraulics, but who need to know the main outlines of hydraulic practice. Two thirds of the text is devoted to turbines, pumps, hydraulic transmissions, and other practical applications. The new edition has been revised and slightly enlarged.

TIMBER, Its Structure and Properties. By H. E. Desch. Macmillan & Co., London and New York, 1938. Cloth, 6 × 9 in., 169 pp., illus., diagrams, charts, tables, $4.50. The aim of this work is to present a summary, in simple, concise language, of the knowledge of the structure, properties, and proper handling of wood which has resulted from the scientific investigations of the various research laboratories which are studying wood.

TOWARD FULL EMPLOYMENT. By H. S. Dennison, L. Filene, R. E. Flanders, and M. E. Leeds. McGraw-Hill Book Co. (Whittlesey House), New York, 1938. Cloth, 6 × 8 in., 297 pp., diagrams, charts, tables, $2.50. A consideration of the unemployment situation from the viewpoint of preventive measures to be applied in the early stages of business recession. A program is presented for the orderly provision of employment through a period of fluctuating conditions, and the necessary financial and taxation systems are discussed.

THEORY OF MECHANICAL REFRIGERATION. By N. R. Sparks. McGraw-Hill Book Co., New York and London, 1938. Cloth, 6 × 9 in., 225 pp., diagrams, charts, tables, $3. The content of this elementary textbook has been restricted to such material as is necessary for a presentation of the fundamental thermodynamic approach to the subject of refrigeration. The practical data included are only those that will assist in interpreting the text of the book. The aim is to present a general demonstration of the application of fundamentals.

THERMODYNAMICS, FLUID FLOW, AND HEAT TRANSMISSION. By H. O. Croft. McGraw-Hill Book Co., New York and London, 1938. Cloth, 6 × 9 in., 312 pp., diagrams, charts,

tables, $3.50. The purpose of this textbook is to review thermodynamics, introduce dimensional analysis, fluid-flow and heat-transmission problems, and to combine this material into one continuous study covering fields of engineering knowledge encountered in actual problems. An elementary knowledge of thermodynamics and hydraulics is assumed.

VDI-FORSCHUNGSHEFT 391, DRUCKÜBERTRAGUNG AN GESCHMIERTEN ZYLINDRISCHEN GLEIT- UND WÄLZFLÄCHEN, by W. Peppler. V.D.I. Verlag, Berlin, July-August, 1938. Paper, 8 × 12 in., 24 pp., illus., diagrams, charts, tables, 5 rm. Pressure transmission in lubricated and in cylindrical sliding and rolling surfaces is discussed in this publication. The development of the important equations, the investigation of elementary hydrodynamic theory, and the dynamical measurement of pressure in grease film are included.

VDI-FORSCHUNGSHEFT 392. ZÜNDVERZUG UND KLOPFEN IM MOTOR. By F. A. F. Schmidt and H. H. Wolfer. V.D.I. Verlag, Berlin, 1938. Paper, 8 × 12 in., 24 pp., illus., diagrams, charts, tables, 5 rm. Contains two articles, one discussing theoretical investigations concerning ignition delay and knock phenomena, the other dealing with the question of ignition delay in Diesel engines.

V.D.I.-FORSCHUNGSHEFT 390, May-June, 1938. AUSTAUSCHBARE QUERPRESSSITZE, By D. N. Wassileff. V.D.I. Verlag, Berlin. Paper 8 × 12 in., 164 pp., illus., diagrams, charts, tables, 5 rm. This report presents the results of an extensive series of tests of shrinkage fits. The test apparatus and method are described, the results obtained given in detail, and conclusions drawn concerning tolerances, temperatures, etc.

VDI-JAHRBUCH 1938. Die Chronik der Technik, edited by A. Leitner of V.D.I. V.D.I. Verlag, Berlin, 1938. Paper, 6 × 8 in., 312 pp., 3.50 rm. This yearbook contains nearly one hundred reports by as many specialists, upon the developments during the year 1937 in various branches of engineering and technology. The reports are accompanied by references to about ten thousand books and articles, thus making accessible a large amount of information on every topic. An extensive index adds to the value of the work.

V.D.I. (Verein Deutscher Ingenieure.) V.D.I.-Sonderheft. DIESELMASCHINEN VII. Berlin, V.D.I. Verlag, 1938. Paper, 8 × 12 in., 155 pp., illus., diagrams, charts, tables, 6 rm. This volume brings together the most important papers on Diesel engines which have appeared in the *VDI-Zeitschrift* and *Forschung auf dem Gebiete des Ingenieurwesens* during the last two years. Thirty-three papers are included, dealing with gas flow, ignition and combustion, engine types, design and construction, and special problems.

VEKTORANALYSIS. (Sammlung Gœschen 354.) By S. Valentiner. Fifth edition. Walter de Gruyter & Co., Berlin, 1938. Cloth, 4 × 6 in., 136 pp., diagrams, charts, tables, 1.62 rm. A brief treatment of vector analysis, covering fundamental definitions, calculations and vectorial operations, uses in various physical fields, and a discussion of linear vector functions, tensions, etc.

VERWERTUNG DES WERTLOSEN, edited by C. Ungewitter and others. Wilhelm Limpert-Verlag, Berlin, 1938. Paper, 6 × 9 in., 304 pp., tables, 7.80 m. A general survey of the numerous varieties of material, customarily neglected, which can be utilized through modern technical procedures. The topics covered include low-grade ores, scrap metal, waste lumber, city refuse, agricultural discardings, rare gases from the air, various minor ocean products, and certain other little considered reclamation possibilities.

VORAUSBESTIMMUNG DER KENNLINIEN SCHNELLÄUFIGER KREISELPUMPEN. By C. Pfleiderer. V.D.I. Verlag, Berlin, 1938. Paper, 6 × 8 in., 45 pp., diagrams, charts, tables, 5 rm. This pamphlet on the predetermination of characteristic curves of high-speed centrifugal pumps contains the derivation of equations for the three principal types, comparisons of the computed curves with test results, flow representation at partial load, and general conclusions on the subject.

DER WÄRME- UND KÄLTESCHUTZ IN DER INDUSTRIE. By J. S. Cammerer. Second edition. J. Springer, Berlin, 1938. Cloth, 6 × 10 in., 315 pp., illus., diagrams, charts, tables, 28 rm. This book provides a concise account of present knowledge of heat-insulation practice. The first section discusses the theoretical principles involved, gives the numerical values of the more important physical magnitudes needed by the engineer, and describes the properties of various insulating materials and the methods of measurement used. The second section considers the calculation and use of insulating materials. This edition has been thoroughly revised.

WELDED STEEL CONSTRUCTION. By R. S. Hale. Pitman Publishing Corporation, New York and Chicago, 1938. Cloth, 6 × 9 in., 170 pp., illus., diagrams, charts, tables, $3. The aim of this work is to provide a simple, concise presentation of welded-steel construction, adapted to the needs of engineers, contractors, and others familiar with structural engineering who are interested in the possibilities of welding in that field. The design of such structures is explained and the principles are illustrated by examples of their practical application. Chapters are devoted to cost estimating, fabrication and erection, and inspection and testing. Appendixes contain useful tables, building codes, specifications, a bibliography, and a list of equipment manufacturers.

DIE ZÜNDFOLGE, der vielzylindrigen Verbrennungsmaschinen, insbesondere der Fahr- und Flugmotoren. By H. Schrön. R. Oldenbourg, Munich and Berlin, 1938. Paper, 7 × 10 in., 375 pp., diagrams, charts, tables, 20 rm. A comprehensive treatment of the subject of firing order in multicylinder internal-combustion engines. The meaning of the subject is explained, regular and irregular firing intervals are considered, and the possible firing orders are set forth. The major portion of the book is devoted to the discussion of the influence of the firing order on, or connection with, power flow, crankshaft and crosshead guide vibration, shaft and bearing load, cylinder charging and discharging, and various minor points.

A.S.M.E. BOILER CODE

Interpretations

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Anyone desiring information on the application of the Code is requested to communicate with the Secretary of the Committee, 29 West 39th St., New York, N. Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee.

This interpretation is later submitted to the Council of The American Society of Mechanical Engineers for approval after which it is issued to the inquirer and also published in MECHANICAL ENGINEERING.

Following is a record of the interpretations of this Committee formulated at the meeting of January 13, 1939, which were subsequently approved by the Council of The American Society of Mechanical Engineers.

CASE NO. 780 (Reopened)

(Special Ruling)

Inquiry: The use of high-strength copper-alloy material as covered by Case No. 864 permits a working stress of 10,000 lb per sq in. at temperatures up to 250 F. Seamless forged pressure vessels of this material having a tensile strength of 52,000 lb per sq in. at room temperature (annealed if required to obtain specified properties), when used at very low temperatures, will have a minimum tensile strength of 55,000 lb per sq in., and elongation and impact values which appear to justify under the Code rules a working stress of 11,000 lb per sq in. Will it be acceptable to design such seamless vessels fitted with bolted covers and having any openings in the cylindrical portion of the shell adequately reinforced under the rules in Par. U-59, using 11,000 lb per sq in. as the maximum working stress, the material in such vessels to be as referred to in Case No. 864?

Reply: In view of the data submitted, it is the opinion of the Committee that the material referred to, if used in seamless forged vessels fitted with bolted covers with all openings in the shell adequately reinforced, will give safe results under a working stress of 11,000 lb

per sq in., provided that the temperature is zero degrees Fahrenheit or below.

CASE No. 836

(Special Ruling)

Inquiry: Is it permissible to fabricate unfired pressure vessels by fusion welding of chrome-nickel molybdenum steel conforming to A.S.T.M. Specifications A 167-38T, grade 6?

Reply: It is the opinion of the Committee that unfired pressure vessels fabricated of austenitic chrome-nickel molybdenum steel conforming to A.S.T.M. Specifications A 167-38T, grade 6, will meet the intent of the Code provided such vessels are constructed in accordance with Par. U-68 with the following limitations:

(*1*) The chemical composition and physical properties shall be modified as follows from A.S.T.M. Specifications A 167-38T, grade 6:

Carbon, max, per cent	0.07[a]
Manganese, per cent	0.40 to 2.50
Chromium and nickel content shall meet the minimum, the exact range being subject to agreement between purchaser and manufacturer to obtain the optimum combination for the service.	
Tensile strength, min, lb per sq in.	75,000
Yield point, min, lb per sq in.	35,000
Elongation in 2 in., min, per cent	30

[a] NOTE: the carbon analysis shall be considered to the nearest hundredth of one per cent.

(2) Maximum temperature 600 F; allowable stress 14,000 lb per sq in., with a joint efficiency of 90 per cent.

(3) In lieu of Par. U-68*j*, the complete vessel shall receive one of the two following heat treatments:

(*a*) Heat to a minimum temperature of 1900 F, and holding for a period of 1 hr per inch of thickness but in no case less than 15 minutes, and cooling rapidly and uniformly from that temperature.

It is important that internal stresses due to quenching be kept to a minimum in order to avoid stress corrosion. Therefore the quenching should proceed as uniformly as possible, quenching from both sides wherever practicable and avoiding steam pockets by auxiliary cooling. The purpose of this heat treatment is to provide maximum over-all corrosion resistance.

Austenitic chrome-nickel stainless steels, when in a condition of internal stress and exposed to certain aqueous chloride solutions may fail by stress corrosion cracking. Consideration should be given to the possibility of stress corrosion cracking in this and other corrosive environments to which the vessel may be exposed in cases where the vessels are to be quenched in accordance with the preceding paragraph.

(*b*) Heat to 1600–1650 F, holding sufficiently long to provide freedom from susceptibility to intercrystalline corrosion, and cooling in a still atmosphere.

The purpose of this heat treatment is to place the vessel in a state of minimum internal stress.

(*4*) The welded test plates shall be made from the same lot of material as the vessel itself, they shall be heat-treated with the vessels, and, if possible, placed inside the vessel.

(*5*) The free-bend test specimen shall be ground and polished and the specimen immersed in boiling copper sulphate sulphuric acid solution for a minimum period of 48 hr. This solution shall consist of 47 cc concentrated sulphuric acid and 13 grams of crystalline copper sulphate ($CuSO_4.5H_2O$) per liter of water. After immersion, the samples shall be bent as specified in Par. U-68. The elongation on the outside fibers shall be not less than 20 per cent, at which there shall be no evidence of fissuring.

(*6*) Representative drillings of the weld metal shall be obtained from one of the welded test plates and the chemical analysis of the weld metal shall be within the same range as the parent metal. In case the chemical analysis of the first drillings of the weld metal fails to meet the foregoing specifications, two additional sets of drillings may be taken from the same welded test plate, and the test shall be considered satisfactory if both these retest analyses meet the specifications.

(*7*) The above provisions may be applied also to chrome-nickel molybdenum steel as covered above with columbium or titanium additions. Vessels of chrome-nickel molybdenum steel of the composition and physical properties covered by (*1*), where the columbium or titanium content is a minimum of 60 per cent of that required in the reply to Case No. 834, may be constructed in accordance with the requirements of Case No. 834.

The lower columbium and titanium content permitted for the chrome-nickel molybdenum steel is due to the stabilizing effect of the molybdenum content.

CASE No. 857

(Annulled)

CASE No. 869

(Interpretation of Par. P-17)

Inquiry: It is our understanding that Case No. 838 permitted the use of screwed staybolts to support a welded joint in a door opening in a vertical boiler with a $^1/_4$-in. thick outside shell, and that it was not the intent of the revision of Par. P-17 to prohibit this construction. Are we correct in this understanding?

Reply: When Par. P-17 was revised to call for a minimum thickness of $^5/_{16}$ in. for plates to which stays could be applied, the case of cylindrical surfaces into which screwed stays might be applied to support other constructions was overlooked. It is the opinion of the Committee that the minimum thickness of $^5/_{16}$ in. does not apply to the cylindrical portion of shell plates.

CASE No. 870

(In the hands of the Committee)

CASE No. 871

(Interpretation of Par. P-112)

Inquiry: Par. P-112*e* requires that a sample welded joint which shall meet the test requirements of Par. P-112*f* shall be made for each 25 or less joints that are welded. Tubes or pipes up to $3^1/_2$-in. outside diameter, inclusive, will not provide satisfactory test specimens as required by Par. P-112*f* (3). Will it meet the intent of the Code if the qualification of the welding process is made on a pipe or tube of such diameter that satisfactory test specimens of the required size may be obtained and if the tests of the welding operator on such small tubes is limited to one free-bend test and one etch test only and, in case of upset tube ends, may the sample weld be made on the original thickness of the tube?

Reply: It is the opinion of the Committee that for tubes or pipes up to $3^1/_2$-in. outside diameter, inclusive, the procedure outlined in the inquiry above will meet the intent of the Code.

CASE No. 872

(Interpretation of Par. P-112)

Inquiry: Is it necessary, under Par. P-112, to qualify the welding process and welding operators in the field for each job before starting work, or will qualification tests at the shop of the manufacturer doing the work suffice if satisfactory evidence of the qualification tests is furnished the field inspector?

Reply: The qualification test made at the shop or elsewhere for any given welding process will suffice for all jobs on which that process is used, provided the work is done by the manufacturer or contractor who has made the qualification tests and is responsible for the welding. Any welding operator who has qualified under a qualified process at the employer's shop need not requalify in the field except as provided in Par. P-112*e*.

A.S.M.E. NEWS

And Notes on Other Engineering Activities

A.S.M.E. Semi-Annual Meeting at San Francisco, Calif., July 10–14

Engineers' Day, July 13, at Golden Gate International Exposition

THE MEETINGS and Program Committee of the A.S.M.E. is to be congratulated upon its choice of San Francisco for the 1939 Semi-Annual Meeting of the Society, for there rising as a veritable "Treasure Island" from San Francisco Bay in one of the most beautiful settings in the history of world's fairs, the Golden Gate International Exposition will be the mecca for many millions of Americans.

Engineers' Day at the Fair

The authorities of the Exposition have set aside Thursday, July 13, as Engineers' Day and there is now being arranged an all-day program with outstanding speakers of international reputation with an all-engineers banquet that evening.

This "Day" is of particular significance to engineers for it is the celebration of the completion of two feats of real engineering, the Golden Gate Bridge with its span of 4200 feet and the San Francisco–Oakland Bay Bridge with two suspension spans each of 2310 feet, three of 1160 feet, and a cantilever span of 1400 feet. The Exposition itself will be held on the largest man-made island, located in the center of San Francisco Bay, of more than 400 acres—more than a mile long and about two thirds of a mile wide. Any of these three is a triumph of engineering but taken together, it is indeed something to be proud of.

While of course the Fair will be a major attraction, an interesting program of technical papers and addresses combined with social events is being worked out to make the Meeting one long to be remembered.

Technical Sessions

Sessions are being planned on aeronautics, fuels, heat transfer, hydraulic equipment, applied hydraulics, management, oil and gas power, boiler plants, mechanical separation, and agricultural engineering—enough topics to satisfy even the most technical-minded.

Hydraulic sessions on the Pacific Coast are always of major interest because of the tremendous amount of hydraulic equipment used in that area. At this meeting a paper is scheduled on the "History of the Pelton Water Wheel," by Dr. William F. Durand, past-president of the Society which is in itself an event of major importance. If present plans work out successfully the paper will be delivered at a joint meeting of the American Branch of the Newcomen Society of England and the A.S.M.E.

Cushing, N. Y.

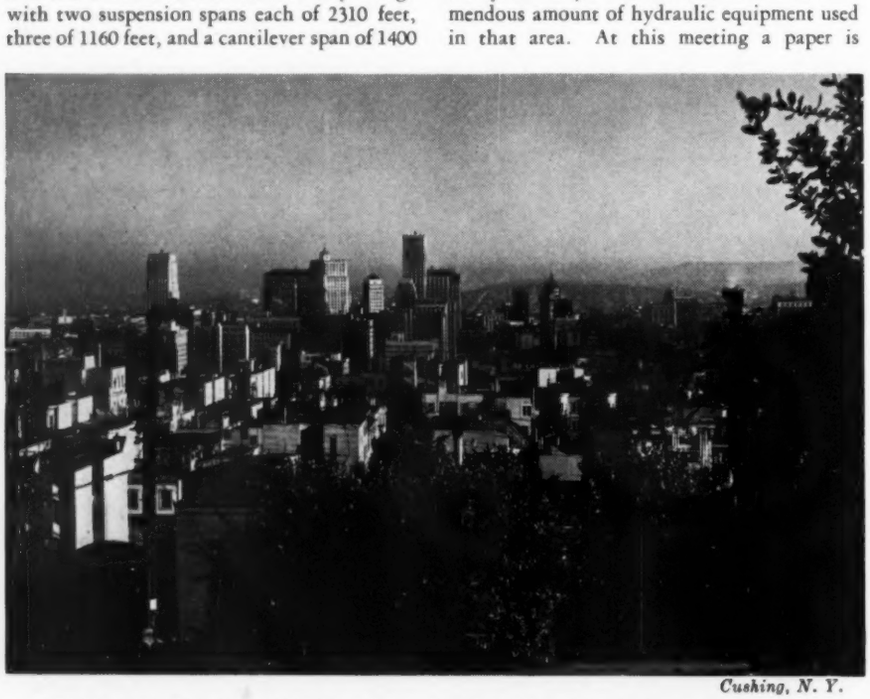
FRAMED BY THE DECKS OF A SAUSALITO FERRYBOAT, IS A VIEW OF THE BIG GOLDEN GATE BRIDGE

Another outstanding contribution will be from Dr. Adolph Meyer of the Brown-Boveri Company, Baden, Switzerland, who has accepted an invitation to attend the Meeting and present a paper on "Gas-Turbine Problems" at a session which will be sponsored by the Oil and Gas Power Division of the Society.

Sessions of the Fuels and Power Divisions will be built along lines of the use of natural gas and petroleum, while the agricultural-engineering session promises much interest also because of the wide application of various mechanical processes to the food industry of California.

Special Tour Planned

Coming as it does in the middle of July the Semi-Annual Meeting at San Francisco will offer an unusual opportunity to members of the Society to include it in their vacation plans. To this end there is being arranged an attractive tour on the all-expense conducted plan with stops at a number of engineering, scenic, and vacation points of interest and pleasure, including the Boulder and Bonneville dams, possibly the Coulee, the 200-inch mirror in preparation at the California Institute of Technology at Pasadena, the structure which



Cushing, N. Y.

SKYSCRAPERS OF SAN FRANCISCO IN A SKY-LINE VIEW FROM LOFTY TELEGRAPH HILL

Cushing, N. Y.

SAN FRANCISCO–OAKLAND BAY BRIDGE IN A SILHOUETTE VIEW TAKEN FROM THE AVENUE OF PALMS ON TREASURE ISLAND, THE SITE OF THE GOLDEN GATE INTERNATIONAL EXPOSITION

will house it at the top of Mt. Paloma, and some of the highest-head hydroelectric plants in the world. After the Meeting a side trip to Alaska and a return journey through the Canadian Rockies with stops at Lake Louise and Banff is scheduled.

Management Division to Be Cosponsor at Johnsonburg

THE MANAGEMENT DIVISION of the A.S.M.E. will be a cosponsor with Stevens Institute of Technology of the ninth annual Johnsonburg Conference in New Jersey this coming summer. Plans are now being prepared and a tentative program will be announced soon.

Fuels Division Broadens Its Service to Members

LESTER C. BOSLER, chairman of the A.S.M.E. Fuels Division, announces that in compliance with the many requests received from the membership of the Society, the Division will attempt to have papers at the various national meetings that will be helpful to all classes of fuel users. At the fuels session of the Spring Meeting in New Orleans, La., there was a symposium on waste fuels from which should come ideas on economical uses for waste materials.

The chairman of the program committee of the Division, Prof. H. O. Croft, State University of Iowa, Iowa City, Iowa, has assembled a comprehensive list of subjects pertaining to fuels, and it is suggested that Local Sections of the A.S.M.E. communicate with him if they are in need of material of this nature for their meetings. He would also appreciate receiving from any member, suggestions of titles of papers with suggested authors on subjects of unusual applications of fuel engineering.

Heat Transfer Group Is Organizing Committees

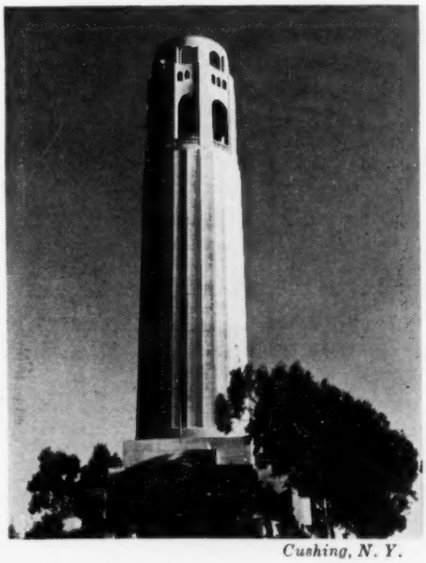
A NEW ADDITION to the professional groups of the A.S.M.E. is the recently formed Heat Transfer Group. After 105 members of the Society had filled out cards indicating their interest in this group, the organizing committee proceeded with the formation of committees on coordination, papers, and testing technique, enrollment of members, and program planning. A fourth committee on thermophysical properties of substances is planned, but not yet organized. Any interested member may obtain an enrollment card from the secretary of the Group, Prof. E. D. Grimison, 209 Main Engineering, State College, Pa.

The Group has scheduled no session for the New Orleans Meeting, but is planning a program for the San Francisco Semi-Annual Meeting under the leadership of Prof. L. M. K. Boelter.

Symposium on Temperature Measurement Planned

A SYMPOSIUM on "Temperature and Its Measurement in Science and Industry" will be held under the auspices of the American Institute of Physics, probably next fall, the dates to be announced later. It is expected that the A.S.M.E. Committee on Industrial Instruments and Regulators will cooperate in the symposium which will cover many fields, its primary purpose according to present plans being to (1) coordinate the treatment of the subject in the sciences and branches of engineering, (2) review principles and bring up to date the record of recent work, (3) accumulate contributions for a comprehensive text, to be published as soon as possible after the holding of the symposium, (4) reveal the subject as an important branch of physics, and (5) supply schools with the information required for the improvement of curricula.

Those interested should communicate with the Institute, 175 Fifth Avenue, New York, N. Y., at an early date, giving information regarding the subject of their contribution.



Cushing, N. Y.

A FAMOUS SAN FRANCISCO LANDMARK

(Concrete shaft, 181 ft high capping Telegraph Hill honors city's most famous volunteer fireman, Lily Hitchcock, who soon after the Civil War was elected a full member of the Knickerbocker Fire Company, No. 5, and answered every alarm with the company.)

President A. G. Christie Welcomed at Milwaukee, Rock River Valley, Peoria, and Chicago

More Than 600 Members and Guests Meet Him and Listen to Paper on Modern Steam Generators

PRESIDENT A. G. CHRISTIE had an opportunity to renew many old friendships and make new ones on his trip to the Middle West during the latter part of January. Everywhere, he was enthusiastically received by members as well as nonmembers of the Society.

Banquet at Milwaukee

The first stop was made on Jan. 24, in Milwaukee where officers and members of the Milwaukee Section outdid themselves in receiving President Christie at a banquet held in his honor at the Wisconsin Club. Also present at this gala function were many engineers from other societies and members of the Milwaukee Athletic Club. The discussion which followed the presidential talk was lively and prolonged.

Rock River Valley Affair

After leaving Milwaukee, President Christie attended the annual President's Night Dinner and Meeting of the Rock River Valley Section in Rockford, Ill., on Jan. 25, at which were present 37 members and guests. After the dinner and preceding his address, he honored E. E. Woodward, a prominent member of the Section, by notifying him of his election to the Fellow grade in the Society and presenting to him the gold emblem of the grade. The talk on "Modern Steam Generators," by President Christie was received with great interest and was followed by a lively discussion, according to our correspondent, Walther C. von Fischer, secretary of the Section. Many questions were asked and answered and soon the discussion found its way to the old argument between Diesel and steam engineers on the relative merits of the two forms of power.

Central Illinois Welcome

Almost 90 members and guests of Central Illinois Section were present at Peoria, Ill., to welcome President Christie on Jan. 26, and listen to his talk on steam generators in which he covered the new developments in the field. He also discussed Society affairs with those present which, more than ever, helped to reaffirm their confidence in the A.S.M.E.

210 at Chicago Reception

On Jan. 27, 210 members and guests of the Chicago Section welcomed President Christie to their annual President's Night at the Medinah Club. Very capable professional entertainment was augmented with organ music played by Ted Day. William L. Abbott introduced the President and Ralph Turner, chairman of the Section, acted as toastmaster. At the conclusion of the talk, a free-for-all discussion was entered into by practically all those present.

Comprehensive One-Day Metropolitan Meeting

ANNOUNCEMENT of a large one-day meeting on April 20 of the Metropolitan Section, was made last month by J. M. Driscoll, chairman of the Section. According to the committee in charge of the meeting, technical sessions, to be held from 2 to 6 p.m., will feature short papers on latest developments by outstanding speakers designated by the various professional groups of the Section, namely, aeronautics, fuels, hydraulics, machine-shop practice, management, national defense, petroleum, power, photography, railroad, sanitation, time study, and transportation.

In the evening, following cocktails, a dinner will be held in honor of Prof. A. G. Christie, President of the Society. After his address, a gala professional show will be put on by some of Broadway's outstanding artists.

Chicago Section to Have Symposium on Statistical Methods in Industry

TWO meetings of especial interest will be held by the Chicago Section of the A.S.M.E. during March. The first one, on March 10, is a symposium on Statistical Methods used in Industry. Papers and their authors follow:

"The Use of Statistics in Industry," by W. J. Ettinger, Edison General Electric Appliance Company, Chicago.

Prof. Walter Bartky of the University of Chicago will lead the discussion of this paper.

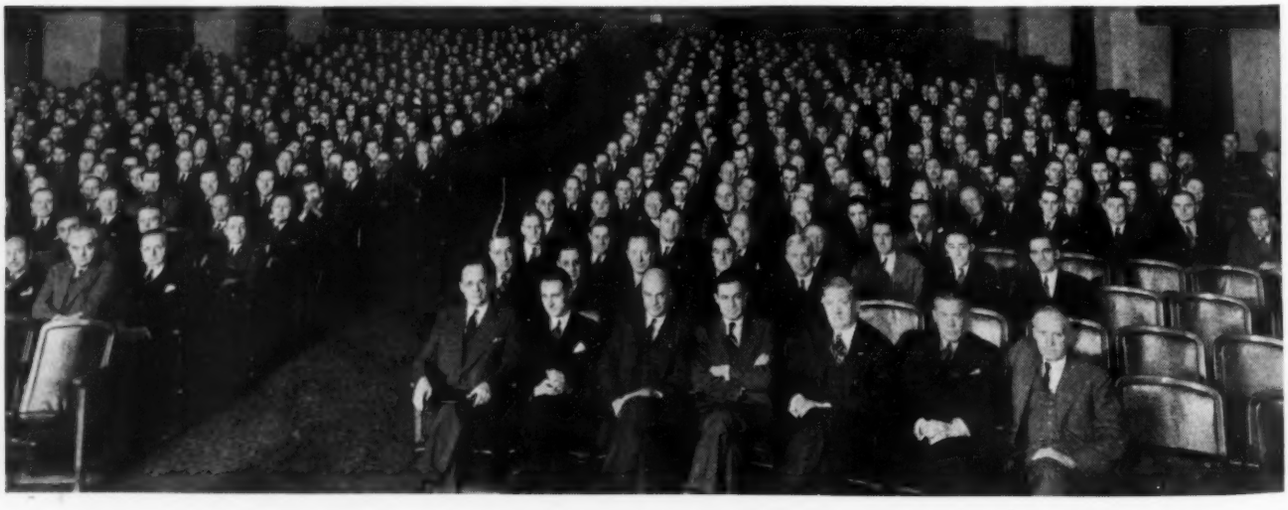
"Statistical Methods in Industry, With Special Reference to the Sampling of Coal," by E. S. Grummell, of Imperial Chemical Industries, Ltd., London.

Dr. Mandl of the Commonwealth Edison Co., J. B. Morrow, vice-president of the Pittsburgh Coal Co., and G. B. Gould, president, Fuel Engineering Co., will comment on Dr. Grummell's paper.

"Developing and Improving Products by Consumer Testing," by Donald R. G. Cowan, Swift & Company, Chicago.

"An Application of Sampling in Quality Control of Manufactured Products," by C. S. Barrett, Western Electric Company, Hawthorne Works, Chicago.

On March 21, R. L. Ledbetter will present a paper on flow of gases in exhaust lines from internal-combustion engines and its relation to engine performance and noise.



DETROIT SECTION MEETING ON JANUARY 18 ATTRACTS 850 TO HEAR JAMES D. MOONEY TALK ON PAPER MONEY

(Center foreground left to right Thomas M. McNiece, Walter Fried, James W. Parker, vice-president A.S.M.E., Max W. Benjamin, chairman, Detroit Section A.S.M.E.. William S. Knudsen, James D. Mooney, member A.S.M.E., speaker of the evening, and O. E. Hunt.)

A.S.M.E. Tri-Cities Section Joint Sponsor of Management Conference, Iowa City, Mar. 31

Devoted to Consideration of Motion and Time Study, Industrial Styling of Products, and the Stabilization of Employment

AGAIN the Tri-Cities Section of The American Society of Mechanical Engineers joins with the College of Engineering of the University of Iowa, the Iowa Manufacturers' Association, and the Society for the Advancement of Management in a Management Conference to be held on March 31, 1939, at Iowa City, Iowa.

Motion and time study, wage incentives, industrial styling of products, and the stabilization of employment will be considered in a well-balanced program of events for the day.

The first of these conferences was held in the spring of 1938 and was attended by over 200 manufacturers and industrial engineers. This year an even larger group is expected.

The program in detail, follows:

8:15 a.m.

Registration. Chemistry Building

9:15 a.m.

Opening Meeting

Address of welcome, Francis M. Dawson, Dean of the College of Engineering

9:30 a.m.

Motion and Time Study

Applying Motion Study in the Factory, by L. S. Whitson, consulting industrial engineer, Minnesota Mining and Manufacturing Co., and member of staff, University of Minnesota

Recent Developments in Motion-Study Research, by Ralph M. Barnes, professor of industrial engineering, University of Iowa

Motion Study applied to Maintenance Work, by Lawrence A. Flagler, industrial engineer, The Proctor and Gamble Co., Ivorydale, Ohio

12:00

Luncheon

(Iowa Memorial Union Building)

1:15 p.m.

Styling of Products

Designing for Appearance, by Harold Van Doren, president, Harold Van Doren and Associates, industrial designers and stylists, Toledo, Ohio

Problems Encountered in Manufacturing a Styled Product, by Ira Maxon, superintendent, Moline Tractor Division, Deere & Co., Moline, Ill.

6:15 p.m.

Dinner

(Iowa Memorial Union Building)

Toastmaster: Huber O. Croft, professor and head of mechanical engineering, University of Iowa

The Stabilization of Employment—Modern Management's Greatest Challenge, by Henry Nunn, president, Nunn-Bush Shoe Co., Milwaukee, Wis.

Committee in Charge

Members of the committee in charge of arranging the Conference are Ralph M. Barnes, member A.S.M.E., chairman, and professor of industrial engineering at the University of Iowa; Charles A. Carlson, secretary-treasurer of the A.S.M.E. Tri-Cities Local Section and connected with the John Deere Plow Works in Moline, Ill.; and Edward A. Kimball, manager of the Iowa Manufacturers' Association, Des Moines, Iowa.

A. V. de Forest Receives I.A.S. Award

A. V. DE FOREST, member A.S.M.E., received the 1938 Sylvanus Albert Reed Award, for his development of the magnaflux method, at the honors-night dinner of the Institute of Aeronautical Sciences in New York on Jan. 27. Others honored included R. C. Newhouse, who received the Lawrence Sperry Award for his development and application of the terrain clearance indicator, and Lester D. Gardner, member A.S.M.E., who was presented with a fellowship in the Institute. George W. Lewis, director of aeronautical research, N.A.C.A., was elected president of the I.A.S. for 1939.

Charles Beensen Wins $712 in Contest

ANOTHER winner in the James F. Lincoln Arc Welding Foundation's contest, whose name was omitted from the list published in the December, 1938, issue of MECHANICAL ENGINEERING, was Charles Beensen, member A.S.M.E., who won first prize of $712.28 in the pump and compressor division.

New Britain, Hartford, and Waterbury Sections Hold Joint Meeting in Bristol, Conn., Jan. 24

Lieut.-Col. K. F. Adamson of U. S. Army Talks on Arms of Infantry Division Before 160

A JOINT MEETING of the New Britain, Hartford, and Waterbury Sections was held on Jan. 24, at the Endee Club in Bristol, Conn. Coming all the way from the Aberdeen Proving Grounds, Aberdeen, Md., where he is chief proof officer, Lieut.-Col. Keith F. Adamson told the 160 members and guests, who were present, about the arms of the infantry division with particular reference to the engineering features involved.

Other things described were the characteristics of the projectiles, powder charges, types of ammunition and range of each, and methods of testing the various components. Some of the tests described were the velocity test, pressure measurement, and recording of recoil.

News of Local Sections

Anthracite-Lehigh Valley Has Welding Session

WELDING covered from both the flame and electric phases, was the subject of the meeting on Jan. 27 of the Anthracite-Lehigh Valley Section in Scranton, Pa. With more than 100 present, the first speaker, A. N. Kugler, Air Reduction Sales Corp., discussed "Pipe Welding in the Field." The second speaker, Magnus Christensen, superintendent, The Babcock & Wilcox Co., described "Electric Welding and Testing of Pressure Vessels." Using slides, he showed heavy-duty pressure vessels for temperature applications from —100 F to 1000 F. The number of first-quality vessels in use now exceeds 10,000 which he attributed to the excellent work done by the A.S.M.E. Boiler Code Committee.

125 Attend Baltimore Besler Boiler Meeting

At the Jan. 11 meeting held in the Engineers Club, 125 members of the Baltimore Section heard George D. Besler, president, Besler Systems, describe his high-pressure boiler and engine. According to Mr. Besler these compact boilers lend themselves very readily to installation in small spaces such as those ordinarily found in boats, airplanes, and trains.

Observatory Described at Birmingham Meeting

Description of the design and construction of the buildings and intricate mechanism of the McDonald Observatory, including motion pictures of the grinding of the 82-in. lens, was

made by L. M. Cole at the Jan. 27 meeting of the Birmingham Section.

Attendance of 300 at Bridgeport Section

Meeting in the Stratfield Hotel on Jan. 12, the Bridgeport Section and Bridgeport Engineers Club presented to the 300, who were present, a talk on optical measurements, by F. J. Loomis. The paper was primarily on the functions of his company's contour-projection machine.

Wickenden Speaks Before 350 at Central Indiana Meeting

Engineers can help alleviate unemployment by developing well-trained men, W. E. Wickenden, member A.S.M.E., declared on Jan. 11 at a meeting of the Central Indiana Section in Indianapolis. He said, talking before 350 members and guests, that a mastery of applied sciences, an instinct of economy, the ability to visualize ideas and to express them clearly to others, are the prerequisites of a good engineer. Prior to the meeting, William A. Hanley, presented a Fifty-Year Badge to William M. Taylor, in recognition of 50 years' membership in the Society.

Central Pennsylvania Has Talk on Safety in Machines

W. T. Cameron, chief safety adviser, Division of Labor Standards, in a talk before the Central Pennsylvania Section meeting at The Pennsylvania State College on Jan. 17, discussed the advantages of building safety into the machine and the process. He showed how the use of safety in designing machinery cuts down on accident hazards.

Unemployment Compensation Discussion at Cleveland

The monthly meeting of the Cleveland Section was held on Jan. 9 at the Case Club. Clarence B. Bartlett, William Odom and Associates, presented a talk on "Unemployment Compensation: Its Effect on Employer and on Employee." This topic, which relates to one of the phases of the social-security program of the present administration, is of great importance to all industries. Mr. Bartlett stated that in those states where a merit-rating plan is in effect, a company should take cognizance of its past deficiencies and, by better control of production and the institution of more satisfactory employee relations, raise its merit rating which in turn will decrease its unemployment tax rate.

Colorado Section Entertains Governor Ralph L. Carr

The Colorado Section conceived the appropriateness of entertaining the new governor of the State of Colorado, the Honorable Ralph L. Carr, at a dinner reception at the Albany Hotel in Denver on Feb. 7. The affair was of such outstanding importance that other engineering groups requested invitations for its members to the affair. In his remarks, Governor Carr told how engineers could best contribute to his plan for a "Bigger and Better Colorado."

Hydraulic Turbines Discussed Before Columbus Members

The theory of design, operation, and installation of large hydraulic turbines, was described by Arnold Pfau, Allis-Chalmers Co., at a meeting on Jan. 27 of the Columbus Section.

Florida Section Hears Maxwell C. Maxwell

More than 60 members and guests were present on Jan. 11 at a meeting of the Florida Section in Jacksonville to listen to a talk on "Materials Handling," by Maxwell C. Maxwell. The discussion which followed the presentation of the talk was both interesting and instructive.

Three Papers Presented at Greenville Section

A joint meeting of the Greenville Section and the Clemson College Student Branch was held on Jan. 11 at the College. After dinner, the 72 members and guests who were present heard three papers on various subjects. Carl G. Planck, student member, described the operation and construction of black-liquor boilers which are used in the manufacture of kraft paper. The second paper was given by Robert L. Henry, student member, on the subject, "The South, the Nation's No. 1 Economic Opportunity," based on the report of the National Emergency Council. The third paper, by J. G. Cluett, Cluett, Peabody & Co., described the "Mechanics of Sanforizing." This was based on a paper on the same subject by his uncle, Sanford L. Cluett, which appeared in the 1933 volume of A.S.M.E. Transactions.

Dinner and Meeting of Kansas City Section

A dinner, followed by a meeting, was held on Jan. 27 by the Kansas City Section. J. A. Kayser, chief refractory engineer, Laclede-Christy Products Co., read a paper entitled, "Modern Refractories."

Louisville Section Members Meet in French Village

A meeting of the Louisville Section was held at the French Village on Jan. 16. Fifteen members were present. After dinner, John H. Romain and Dean F. L. Wilkinson gave a report on the 1938 Annual Meeting in New York. L. L. Amidon talked on the Local Sections' delegates conference in Columbus, held prior to the New York meeting.

Metropolitan Section Has 500 at Elevator Meeting

Under the auspices of the Transportation Division of the Metropolitan Section, the meeting of Jan. 19 featured the subject of "Vertical Transportation." Sidney Otis, Otis Elevator Company, was chairman, and F. K. Kebelman, general sales engineer of the company, was the speaker. His talk, delivered to 500 members and guests, was divided into three parts, namely, engineering problems of vertical transportation, safety devices, and standardization.

Minnesota Members Visit University Laboratories

Following a dinner at the Minnesota Union, on Jan. 20, the members of the Minnesota Section adjourned to the heating and ventilating laboratories of the University of Minnesota where a series of slides of the different setups of machinery and apparatus was shown, followed by actual demonstrations by Prof. Frank B. Rowley, member A.S.M.E. Of particular interest was the study of wall insulation and materials of construction.

W. R. Woolrich Explains Quick Freezing to North Texas Section

About 65 members of North Texas Section and their ladies attended the first "coed" dinner meeting on Jan. 9, the first ever held by the Section. Dean W. R. Woolrich, member of A.S.M.E. Council, gave a talk on his personal experiences with quick freezing of fruits, vegetables, and meats. The talk proved to be very interesting to all, especially to the ladies in attendance.

Oregon Section Holds Business Meeting

Due to a large accumulation of unfinished business, it was necessary to call a business meeting of the Oregon Section on Jan. 20 to settle some of the unfinished questions, such as recommending applicants to the Society's Admissions Committee, and deciding on inviting the Society to have a National Meeting in Portland.

Petroleum Night at Philadelphia

About 170 members and guests attended the petroleum night meeting of the Philadelphia Section on Jan. 24. W. H. Waterman, Byron-Jackson Co., gave a paper on "Centrifugal Pumps for High Temperatures and High Pressures," and Paul Clarke, Clark Bros. Co., spoke on "Gas Expanders and Gas Compressors." L. N. Goldsmith led the discussion from the floor.

M. C. Maxwell Speaks in Raleigh, N. C.

Materials handling was discussed by Maxwell C. Maxwell in a paper presented before the Raleigh Section on Jan. 6. More than 60 members and guests attended and thoroughly enjoyed the meeting.

Fuel Pumps Explained at Rock River Valley Section

Modern development of fuel-injection pumps for high-speed Diesel engines was the principal subject of a paper on Jan. 19 by C. R. Alden, Ex-Cell-O Corp., before 90 members and guests of the Rock River Valley Section at Beloit, Wis. Some of the guests were A.S.M.E. members from as far away as Peoria and Chicago. R. C. Glazebrook, chairman of the Section, announced that the next meeting would be held in Rockford on Feb. 16, and have L. W. Wallace, vice-president of the A.S.M.E., speaking on "Industrial Research."

National Defense Day Meeting in San Francisco

Following an inspection trip to Crissey Field to see antiaircraft batteries in action, the National Defense Day program of the San Francisco Section on Jan. 26 was continued with a dinner and meeting in the evening. Lieut.-Comdr. A. F. Bonnalie, United Air Lines, spoke on "The Development of Naval Aircraft," and Maj. W. C. Braly, professor of mili-

Itinerary of C. E. Davies, A.S.M.E. Secretary

Feb. 27–Mar. 14

Feb. 27: Louisiana State University Student Branch, Baton Rouge, La.

Feb. 28: Mississippi State University Student Branch, Starkville, Miss.

Mar. 1: Birmingham Section, Birmingham, Ala.

Mar. 2: Alabama Polytechnic Institute Student Branch, Auburn, Ala.

Mar. 3: Georgia School of Technology Student Branch
Atlanta Section, Atlanta, Ga.

Mar. 6: University of Florida Student Branch, Gainesville, Fla.

Mar. 7: Savannah Section, Savannah, Ga.

Mar. 8: Greenville Section, Greenville, S. C.

Mar. 9: Clemson College Student Branch, Clemson College, S. C.

Mar. 10: Knoxville Section and University of Tennessee Student Branch, Knoxville, Tenn.

Mar. 13: Charlotte Section, Charlotte, N. C.
Duke University Student Branch, Durham, N. C.

Mar. 14: University of Virginia Student Branch, Charlottesville, Va.

tary science and tactics, University of California, talked on "Antiaircraft Defense." According to H. B. Langille, secretary of the Section, this was considered one of the most successful meetings held by the San Francisco Section.

Fire Fighting Reviewed by Schenectady Section

With Chief James J. Higgins of the Schenectady Fire Department as chief speaker, the Schenectady Section on Jan. 19 held an open forum on fire fighting.

South Texas Demonstration on Feedwater Conditioning

At the meeting of Jan. 27 in Houston, Texas, more than 70 members and guests of the South Texas Section saw Charles E. Joos, The Cochrane Corp., demonstrate a model power plant, operating on the temperature difference between wet and dry section of tubing. Using the model and slides, Mr. Joos described the latest practices which are in use in feedwater conditioning.

Women's Prejudices Control Mechanical Developments, Virginia Engineers Told

If engineers want to take their "proper place in society of which they are a part" and put their developments to the best and happiest human use, they'd better study the "unscientific, capricious, but sound prejudices" of women who don't like engineering products that "just don't click." So said John C. Parker, member A.S.M.E., and president, A.I.E.E. at a joint meeting in Richmond, Va., on Jan. 20–21 of the Virginia sections of the A.S.M.E., A.I.E.E., A.S.C.E., A.I.Ch.E., and A.I.A. Other speakers in the two-day program included H. H. Snelling, vice-president of the A.S.M.E., Governor Price of Virginia, and Mayor Bright of Richmond.

Washington, D. C., Hears of Enamels in Engineering

In a lecture on "Enamels in Engineering," presented at the Jan. 19 meeting of the Washington, D. C., Section, William N. Harrison covered the use of enamels in building construction, particularly in fabrication of metal shingles and decorative store fronts.

Author of "Labor's Road to Plenty" at Worcester

With 30 members and 62 guests present on Jan. 19, Worcester Section presented as speaker, Allen W. Rucker, president, Eddy, Rucker, and Nickels, and author of "Labor's Road to Plenty." Mr. Rucker's talk covered not only the analysis of business and economic trends but also his share-of-production wage plan.

Junior Group Activities

Junior Members Are Speakers Before Philadelphia Group

AT THE Jan. 11 meeting of the Philadelphia Junior Group, E. G. Althouse, junior A.S.M.E., of the Yarnall-Waring Company, gave a talk on "How the Impulse Steam Trap Works." The other speaker of the evening was J. H. Peterson, junior A.S.M.E., of the Schutte & Koerting Company, who read a paper on "High-Vacuum Equipment."

A week later, the Group made an inspection trip to the Schuykill Station of the Philadelphia Electric Company to see the recently installed superimposed turbine which has a rating of 1200 psi and 900 F.

Tri-Cities Junior Group Visits Rubber Factory

INSTEAD of a meeting on Jan. 13, the Tri-Cities Junior Group visited the Servus Rubber Company in Rock Island, Ill. Numbering 21, the group was conducted through the plant by Ed Witt and M. Goethals. The various steps in the manufacture of rubber footwear was observed, beginning with the mixing of rubber with various other materials and ending with the vulcanizing and tempering process.

San Francisco Juniors Help National Defense Program

AS PART of the National Defense Day program of the San Francisco Section on Jan. 26, the Junior Group arranged and conducted an afternoon inspection trip to Crissey Field, San Francisco, where members looked over the defense equipment of the 65th Coast Artillery of the U. S. Army, including searchlights, sound detectors, sound locators, control stations, 3-in. antiaircraft guns, height finders, and machine guns. This was followed by a dinner and meeting of the Section in the evening, full details of which may be found in the Local Sections News.

On Jan. 19, the San Francisco Junior Group held its sixth seminar; the topic of the meeting was National Defense. James Q. Brett of Coldwell, Cornwall, and Banker, discussed the various phases of industrial mobilization. He covered the purposes and aims of this part of the mobilization of the Nation in time of war. Joseph F. Zorn, Jr., of the Pacific Gas and Electric Co., described the operation of the various instruments required for the control and direction of antiaircraft guns. He also included a short description of the guns, shells, and ballistics.

Detroit Junior Group Learns About Hydraulic Couplings

A TECHNICAL Meeting of the Detroit Junior Group was held on Jan. 10, at which R. Nelon, junior A.S.M.E., of the American Blower Corporation, gave a paper on fluid couplings, illustrating his talk with drawings and line diagrams of several types of couplings which are manufactured by his company.

Following him, J. C. Webb, junior A.S.M.E., of the J. B. Webb Company, presented a talk on materials handling. He traced the beginnings in this field and described recent developments. After the conclusion of his talk, he showed a motion picture of materials-handling equipment in the Packard Motor Car Company.

Cleveland Juniors Inspect Broadcasting Studios

THE STUDIOS of the National Broadcasting Company station, WTAM, were inspected on Jan. 17 by the Cleveland Junior Group. The 30 who were present saw the various types of instruments and microphones and learned something about their applications. Also shown were a multitude of gadgets which have become so essential in the efficient operation of a broadcasting station. Some members of the party looked over the rooms containing the air-conditioning apparatus.

With the Student Branches

Holiday on March 17 Honors St. Patrick
Patron Saint of Mechanical Engineers

Thousands of Engineering Students Will Take Part in Parades, Exhibits, Dances, Smokers, and Gala Parties

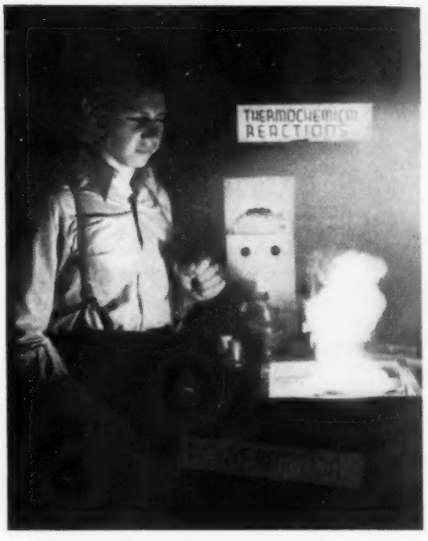
MARCH 17 is a green day on the calendar of every mechanical-engineering student because it celebrates the achievements of genial St. Patrick, the first mechanical engineer. Whether he achieved this honor—for it is an honor to be a mechanical engineer—by his discovery of the famous "blarney" stone or his development of the first "worm drive," as related in the tales brought down through the centuries, it, nevertheless, remains for us moderns to keep alive his memory and his achievements. Very few members of the present generation know this but 59 years ago The American Society of Mechanical Engineers honored him by adopting his four-leaf clover as the badge of membership in the Society. 'Tis said by many a famous engineer that this emblem of St. Patrick has helped him in finding a job and making a success of it.

History of Celebration

After painstaking searching and countless interviews, the details were finally obtained of the origin of the celebration of St. Patrick's Day by mechanical engineering students from none other than Prof. Walter Rautenstrauch, of Columbia University, and Prof. F. G. Hechler, of The Pennsylvania State College. According to their accounts, it was originated on the afternoon of March 16, 1902, at the University of Missouri by the graduating class in mechanical engineering, which included, besides Professor Rautenstrauch, George Morehead, vice-president, Link Belt Co.; John Brundage, Electric Bond and Share Co.; Gay A. Robertson, chief engineer, Atlantic Coal and Ice Company; and Prof. Earl B. Smith, College of the City of New York.

In Missouri, spring often comes early and by mid-March the grass is ready to mow and the days are warm and lazy. In 1902, there was no break in the college schedule between Christmas and June. Working in the hot drafting room that afternoon, Walter, the student, suggested that the group should not forget to pay honor to St. Patrick on the morrow, and to let the world know what a great engineer this worthy Irishman was. In Professor Rautenstrauch's own words, "classes were cut the next day and various sorts of devilment were engaged in in an unorganized fashion. We each had girl friends and they were persuaded to cut class, perhaps I should say invited, and an inspection of the green woods, the color appropriate to the occasion, was made."

In other words, the occasion was little more than a walkout for the day, except in a few cases where the faculty, including Prof. Arthur M. Greene, now dean of engineering at Princeton University, took too decided a stand against the procedure. In 1904, the first posters appeared, during the night of the sixteenth, announcing the celebration and a holiday, both at the University in Columbia and at the School of Mines at Rolla. But it was not until the following year that the celebration was well organized, with parade, band, open house, dances, dinners, etc., including the ceremony of knighting the senior engineers by one of their number impersonating St. Patrick. Before Dean Greene left Missouri in 1906, he was thoroughly converted to the plan and appreciated its value for consolidating the student body in the school of engineering, and supported it so wholeheartedly that he was made an honorary knight of the patron saint of mechanical engineers. From Missouri, the custom spread to neighboring institutions.



OPEN HOUSE—THERMIT REACTION

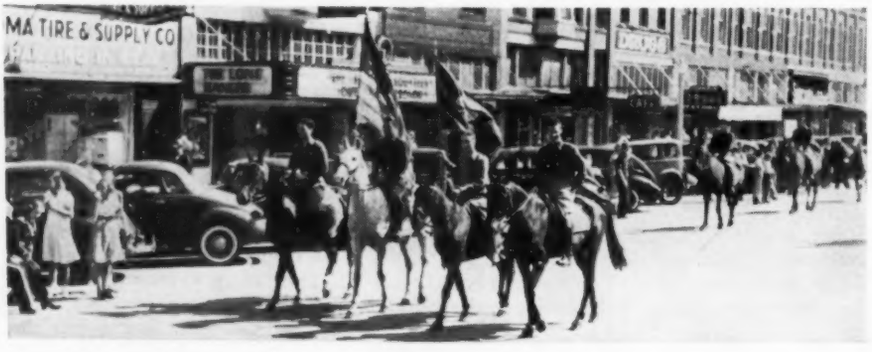
Minnesota Started It in 1903

Whether it was brought from Missouri or directly from Ireland, the custom started at the University of Minnesota in 1903 with the finding of a large stone on the campus bearing the inscription, "Erin Go Bragh," which means, in our language, "St. Patrick Was a Mechanical Engineer." A group of senior students decided that this must be a message from St. Pat, himself, and with all due awe and respect for omens, dedicated the day to the honoring of St. Patrick, the patron saint of mechanical engineers.

The year 1910 marked the turning point for St. Patrick's Day activities at the University of Minnesota. Until this year, the only means of celebration was the annual All-Engineering dance in honor of St. Pat. Under the leadership of Prof. George C. Priester, then in his first year as an instructor, the plan of activities as used since that time was devised, including the parade, the open house, the brawl, and the dansant. In 1938, the date was moved up to May to increase the chances of good weather. Also, two days, instead of one as heretofore, were set aside. For St. Patrick was a mechanical engineer and he would have it so.

Program at Oklahoma

Because of the interest evinced by many schools which are preparing to celebrate St. Patrick's Day, the following program from the University of Oklahoma, sent in by W. F. Ford, secretary of the A.S.M.E. Oklahoma Branch, together with photographs on this and the following page, is herewith reproduced.



THE PARADE

OPEN HOUSE—THE QUEEN AND ST. PAT OPEN EXHIBITS

March 9. Election of the Engineers' Queen and St. Patrick. The queen is selected from five candidates by secret ballot. Only members of the Engineers' Club, composed of students from all branches of engineering, are permitted to vote. St. Patrick, a senior student, is elected in a similar manner. Names of successful candidates are not announced until the night of March 17 at the annual Engineers' Ball.

March 16. Engineers' Stage Show. A show is held in one of the town's theaters on this night. Proceeds from the show are used to finance expenses incurred during the celebration.

March 17. Engineers' Ball, Coronation, and fireworks. The dance starts at 9 p.m. and continues to 12 p.m. At 10:15 p.m., the identity of St. Pat is revealed. He then crowns the queen amid an impressive ceremony.

Immediately after the ball, the annual fireworks demonstration is held, during which the "Loyal Knights of Old Trusty" fire "Old Trusty," an ancient cannon, in celebration of St. Patrick's Day. In 1931, Old Trusty burst and a member was injured. A new cannon was secured by next year. At another time, the fireworks all went off at once.

March 18. Open House and Engineers' Banquet. All of the schools of the college of engineering join in presenting the Open House. The program is begun with the engineers' parade through the campus and the downtown area of Norman. The queen and St. Patrick officially open the Open House at 10 a.m. in a colorful ceremony on the steps of the engineering building. From then until 10 p.m., visitors are shown all kinds of exhibits prepared by the students and the latest developments in engineering equipment exhibited by representatives from companies throughout the Southwest. Last year, more than 10,000 attended Open House.

In the evening, all students, faculty members, and practicing engineers from the Southwest are present at the Engineers' Banquet to bid farewell to St. Patrick. The queen concludes the evening by dubbing those engineering students who have been chosen to become Knights of St. Patrick.

N.Y.U. Plans City-Wide Affair

The N.Y.U. Branch of the A.S.M.E. has extended an invitation to all student members and regular members of the Society in New York City and vicinity to attend the first St. Patrick's Day Celebration by engineers ever held in the city. Following dinner in the Commons at University Heights, price 75 cents, a program will be held in the University's Chapel. It will feature talks on how to obtain employment by a prominent engineer, after which St. Patrick, in person, will be introduced. He will demonstrate how he made the first "worm drive." Then the members of the engineering faculty, arrayed in full academic costume, will march down the aisle to the platform where St. Pat will confer upon them pseudo-honorary degrees and read aloud the citations which accompany each degree. Further details may be obtained from Prof. Charles E. Gus, New York University, University Heights, N. Y.

HAIL! THE QUEEN!

Celebration Is Nation-Wide

Other schools which honor St. Patrick in appropriate manner are the University of Alabama, University of Illinois, Rose Polytechnic Institute, Villanova College, University of Arkansas, and many others. It is hoped that the custom will spread so that, eventually, the President of the United States will declare March 17 a national holiday in honor of St. Patrick, the first mechanical engineer.

Here and There

A.S.M.E. Student Branch Established at New Mexico

NEW MEXICO STATE COLLEGE BRANCH joined the ranks of A.S.M.E. Student Branches when the Society's Committee on Relations With Colleges at its December meeting approved the establishment of a Student Branch. This makes 118 Student Branches. Officers of the Branch are: Gene Gray, chairman; Carlton McGregor, vice-chairman; Robert Yates, secretary; Wayne Ward, treasurer; and Prof. M. T. Lewellen, honorary chairman.

ARIZONA BRANCH at its election of officers on Jan. 18 for the second semester elected Fred Clark, as chairman; Angus McVicar, as vice-chairman; Thomas Tizard, as treasurer; and Houston Dameron, as secretary.

A.S.M.E. History at California

Main speaker of the meeting of CALIFORNIA BRANCH on Jan. 18 was Prof. B. F. Raber, who talked on "The A.S.M.E., Past and Present," illustrating his lecture with slides showing photographs of the founders. Of particular

DREXEL TECH STUDENT BRANCH BOOTH IN THE COLLEGE'S ANNUAL OPEN HOUSE

interest was his comparison of the Society with similar European engineering societies.

CALIFORNIA TECH BRANCH held a joint meeting with the A.I.E.E. on Jan. 13, at which Dr. F. C. Lindvall described to the 120 who were present, the features of the new pendulum railway car of which he is the codesigner. In this type of construction, the car is hung at the top from beams which extend upward from the trucks. Therefore, when rounding a curve, the car body swings out and the effect is essentially the same as though the tracks were banked. In the afternoon, the boys visited the Sante Fe yards where they saw two full-size models of the pendulum car. Also shown was the new Sante Fe "Super Chief" Diesel-electric locomotive. On Jan. 23, members of the Branch made an inspection trip to the Hancock Oil Company's refinery at Long Beach.

Case Has 102 Members

For the first time in its history, the CASE BRANCH has a membership of 102. Congratulations to the Junior students for its 100 per cent record.

CATHOLIC UNIVERSITY BRANCH had two speakers on Jan. 11, Paul O'Neill, chairman of the Branch, who gave an interesting paper on the water-vapor system of refrigeration, and Frank Taylor, Smithsonian Institution, who presented a very interesting lecture on the history of engineering.

CLEMSON A.&M. BRANCH held a joint meeting with the Greenville Section of the A.S.M.E. on Jan. 11. There were present 36 student members and 26 A.S.M.E. members. Student members C. G. Planck and R. L. Henry, and J. G. Cluett, Cluett, Peabody & Co., read papers. Full details will be found on page 256 of this issue.

COOPER UNION BRANCH had 150 student members and guests present on Jan. 3 to see the motion-picture film entitled, "Bridging San Francisco Bay," which was a pictorial story of the construction of the San Francisco–Oakland Bay Bridge.

Cornell Has Model Railroad

The Cornell & Cayuga Railroad, an exclusive corporation with six members who pay dues of 50 cents a week, has constructed 700 sq ft of table space in the home of Dean S. C. Hollister of the college of engineering, Cornell University, and is now laying out the first section of a projected 1200 ft of 0-gage track. Rolling stock at present consists of three locomotives and 12 cars built to scale by the students themselves. President of the railroad company is Colin Eldridge, member of the CORNELL BRANCH.

DETROIT BRANCH showed several motion pictures from Chevrolet at the meeting on Jan. 12. Titles were "On Two Wheels," a dramatic illustration of traffic laws; "Over the Waves," a representation of the ups and downs of a motorcar ride; "Behind the Mike," a story of the secrets of radio sound effects; and "Materials," a description of the paths of raw materials to finished products.

DREXEL TECH BRANCH members learned the secrets of "Obtaining an Interview for Employment," from George Harvey, personnel manager with the Philadelphia Electric Company, at the meeting of Jan. 19.

FLORIDA BRANCH had Howard H. Gray, secretary of the Branch, give a paper on wind tunnels, at the meeting held on Jan. 6.

750 Attend Illinois Meeting

Before starting the program of the meeting of Jan. 11, which was attended by 100 student members and 650 guests, J. R. Poyser, chairman of the ILLINOIS BRANCH, introduced R. P. Molt, president of Pi Tau Sigma. Mr. Molt then made the annual award of a Marks' "Mechanical Engineer's Handbook," to R. E. Levine, who received the highest marks of all the mechanical engineering freshmen last year. Then, the motion picture, "Steel—Man's Servant," was shown.

IOWA BRANCH officers for the second semester were installed on Feb. 1. They are John Wessale, chairman; Robert Miller, vice-chairman; Henry Hardaway, secretary; and Prof. Ralph M. Barnes, honorary chairman.

IOWA STATE COLLEGE had a coed meeting on Jan. 25 to which student members brought their "dates." Two movies were shown, "Coast to Coast With United Air Lines," and "The Drake-Iowa State Football Game," in color.

Doctor Speaks at Kansas State

KANSAS STATE BRANCH believes that nontechnical as well as technical talks should be included in its program. Therefore, on Jan. 19, before 160 members and guests, Dr. E. J. Frick, head of the department of surgery and medicine of the veterinarian division of the College, told of his travels during the summer in England, Holland, Poland, Belgium, France,

STUDENT MEMBERS OF NORTH CAROLINA STATE COLLEGE STUDENT BOARDS HOLD PARTY IN COLLEGE POWER PLANT ON JANUARY 19 AS A PRELUDE TO SENIOR STUDENTS' ANNUAL POWER-PLANT TESTS THE NEXT DAY!

Germany, Hungary, and Switzerland. Of particular interest were his comments on the political, economic, and social problems of Germany. Before the meeting adjourned, Howard Stover, student member, presented the Branch with a new gavel. (Who broke the last one?)

KENTUCKY BRANCH had Professor Cheek give a talk on Jan. 13, on the setup and operation of the new hydraulics laboratory at the University.

LAFAYETTE BRANCH had an attendance of 110 at its meeting of Jan. 11. The audience heard John Hays Allen, class of '77, and president of the Everlasting Valve Co , speak on "Some Human and Technical Aspects of Valve Manufacture."

L.S.U. Free Trips to New Orleans

At the meeting of Feb. 1, Dean La Salle announced that the school will pay the transportation expenses of student members of the LOUISIANA STATE BRANCH to the Spring Meeting of the A.S.M.E. in New Orleans, Feb. 23–25.

LOUISVILLE BRANCH at its meeting of Jan. 26 had technical papers presented by Riester, on "Power Improvement During 1938," by Bass, on "Aluminum Alloys in the Railway Industry," and by Whitehead, on "Steam-Jet Refrigeration."

MAINE BRANCH members heard all about the 1938 Annual Meeting of the A.S.M.E. from Prof. W. J. Sweetser at the meeting on Jan. 9. Smokes, cider, and doughnuts were served after the conclusion of Professor Sweetser's interesting discussion.

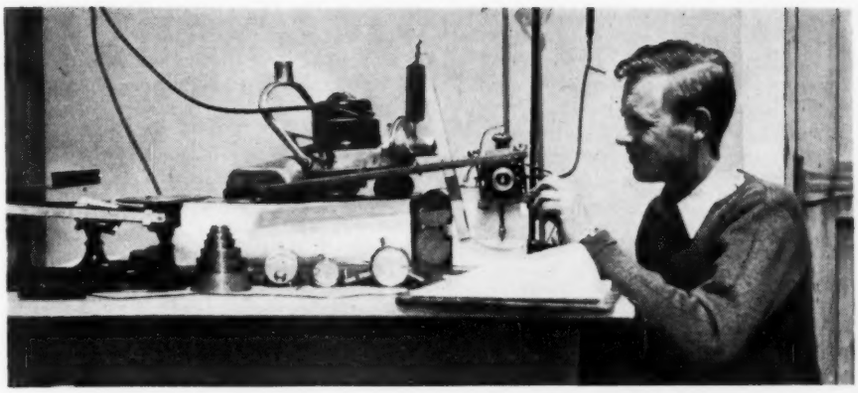
MARQUETTE BRANCH meeting of Jan. 26 had as guest speaker, J. Alexandroff, consulting engineer, Pate Oil Co., who described the origin and functions of oil. There were 125 at the meeting.

J. W. Parker Speaks at Michigan

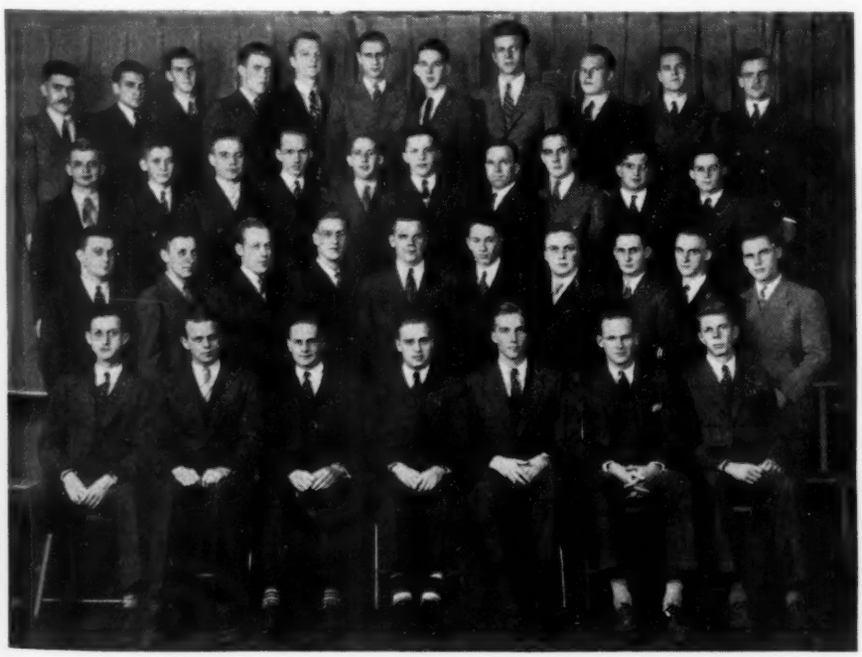
James W. Parker, vice-president of the A.S.M.E., was the speaker of the evening at the meeting of the MICHIGAN BRANCH on Jan. 11. Based on his experiences as chief engineer of The Detroit Edison Co., he gave a very interesting talk on limitations in steam power-plant development, illustrating his remarks with slides showing diagrams of various boiler cross sections, stokers, waterwalls, and superheaters. He also discussed single- and double-end firing, and suspended ash precipitation. After the meeting, which was attended by about 100 students, a few more signed up for membership, bringing the enrollment to 117.

MICHIGAN STATE BRANCH members will act as guides in the engineering laboratories of the College during Farmer's Week. At the meeting of Jan. 24, papers were presented by Victor C. Carlson, Robert C. Clough, Donald Duffman, Arnold Johnson, H. S. Keller, and Arthur Kerkau.

MICHIGAN TECH BRANCH took part in the Winter Carnival on Feb. 3 and 4. Although the A.S.M.E. snow statue of a streamlined train did not receive a prize, it received much favorable comment. The A.S.M.E. float for the parade was a large wooden gear with 175 teeth representing the 175 mechanical-engineering students in the College.



JAMES RYDER, A.S.M.E. STUDENT MEMBER, UNIVERSITY OF SOUTHERN CALIFORNIA, IS SHOWN DEMONSTRATING A 1/5 HP GASOLINE ENGINE WHICH HE BUILT AND DESCRIBED AT A MEETING OF THE STUDENT BRANCH OF U.S.C.



MEMBERS OF A.S.M.E. STUDENT BRANCH AT MICHIGAN STATE COLLEGE

Montana State Meets in Steam Lab

For the first time, a meeting of the MONTANA STATE BRANCH was held on Jan. 19 in the steam laboratories, which has been turned over to the Branch for its future meetings. Speaker at the meeting was George Reed, who worked on the construction of the Fort Peck Dam during the summer.

MISSISSIPPI STATE BRANCH at its meeting of Feb. 1 had Prof. E. L. "Buddy" Lucas, whose subject was "What a Man May Rightfully Expect Upon Graduation."

NEVADA BRANCH will cooperate in Engineers' Day and, consequently, a committee for that purpose was chosen with Elkins as chairman.

NEWARK COLLEGE BRANCH had for its speaker on Jan. 16, Gosta Ambro, power-plant engineer, Colgate-Palmolive-Peet Co., who spoke on the distribution of steam in the industrial power plant and related problems.

N.Y.U. BRANCH (evening) members got some very good advice on Jan. 18 from their honorary chairman, Prof. Charles E. Gus, on the employment situation, particularly with regard to new connections which are available for experienced and suitably qualified men.

N. C. State to Make Two-Day Tour

At the meeting of Jan. 10, members of NORTH CAROLINA STATE BRANCH made plans to make a two-day tour of central North Carolina. Six different industries are included in the itinerary.

OHIO NORTHERN BRANCH on Jan. 12, with 69 present, had as guest speaker, J. O. Everett, chief designer, Buckeye Machine Co. His talk was on the "Design of a Diesel Engine."

PRATT INSTITUTE at its meeting of Jan. 12, had two members of the faculty, Messrs. Schmidt and Quier, talk on "What Is Engineering Education?"

225 at Purdue Meeting

P. S. JACKSON, assistant manager, Rockford Tool Machine Company, spoke to the PURDUE BRANCH on Jan. 11. His subject, "The Application of Hydraulics to Machine Tools,"

OPEN HOUSE—DRILLING OIL WELL

proved to be very interesting to the 100 student members and 125 guests who were present.

RENSSELAER POLY BRANCH at its meeting of Feb. 2, presented two reels of talking motion pictures showing the production of General Motors automobiles. The titles of the pictures were "Raw Products" and "Vacuum Control."

SOUTHERN CALIFORNIA BRANCH members visited the Pasadena power plant on Jan. 16.

A.S.M.E. Calendar

of Coming Meetings

April 5, 1939
Textile Meeting
Greenville, S. C.

June 14–15, 1939
Applied Mechanics Division
New York, N. Y.

June 19–22, 1939
Oil and Gas Power Division
Ann Arbor, Mich.

July 10–15, 1939
Semi-Annual Meeting
San Francisco, Calif.

September 4–8, 1939
Fall Meeting
New York, N. Y.

October 5–7, 1939
Joint Meeting of A.S.M.E. Fuels and A.I.M.E. Coal Divisions
Columbus, Ohio

October, 1939
Wood Industries Division
Boston, Mass.

December 4–8, 1939
Annual Meeting
New York-Philadelphia

Student speaker at the meeting of Jan. 20 was James Ryder, who gave a paper on "Performance Tests on a 1/5-Hp Gasoline Engine." A photograph of Mr. Ryder demonstrating the engine which he built is shown on page 261 of this issue.

SOUTHERN METHODIST BRANCH at its evening meeting of Jan. 19 showed a motion picture from the U. S. Bureau of Mines on "The Evolution of the Oil Industry."

W. R. Woolrich at Texas

Dean W. R. Woolrich, Member of A.S.M.E. Council, spoke before the TEXAS BRANCH on Jan. 2 of his trip to the 1938 Annual Meeting of the Society in New York. He suggested that the last meeting of the Branch be devoted to a discussion of the relationship between labor and ethics in regard to engineering.

TEXAS A.&M. BRANCH had 230 present at the meeting on Jan. 10. A. M. Chase, York Ice Machinery Corporation, gave a short talk on air conditioning after which he presented a motion picture on the manufacture and distribution of refrigerating machinery. The Branch now has 137 members.

TEXAS TECH BRANCH members on Jan. 10 heard a paper on "Embrittlement of Steels in Steam Boilers," given by Henry Meredith, chairman of the branch.

Boiler Session at Toronto

TORONTO BRANCH had a boiler session on Jan. 17, at which H. D. Dick, student member, spoke on "Testing Boiler Feedwater for Embrittlement Producing Qualities," and C. R. Phillips, student member, talked on "Types of Fans for Artificial Draft." Then the speaker of the evening, W. H. D. Clark, chief engineer, Combustion Engineering Corp. of Montreal, presented a paper on "Boiler Design."

TULANE BRANCH reports that during the last semester two contests were held for the best papers presented at a Branch meeting. Byron Levy won the sophomore contest with a description of "The Hydraulic Press," and Donald E. Jahncke came out first in the junior and senior contest with a paper on "The Social Responsibility of the Engineer."

UTAH BRANCH had two motion-picture films shown at the meeting of Jan. 18. They were on the mining of coal and its various uses and on the mining of copper.

Washington and Jobs in India

On Jan. 5, G. K. Hillman, a graduate of the University, gave a very interesting talk before the WASHINGTON BRANCH on his experiences in India as an engineer with the Standard Oil Co. of New York. The meeting of Jan. 19 saw the presentation of papers by Robert Beaver, William Evans, Otis Lamson, John Finnigan, and William Field.

GEORGE WASHINGTON BRANCH had as guest speaker on Jan. 3, Maxwell C. Maxwell, who talked on "Materials Handling."

WORCESTER POLY announces a million-dollar program of building construction and development. The program includes an addition to Salisbury Laboratories, now in construction, and remodeling the old building, at a cost of $100,000, and erection and equipment of a mechanical-engineering building for $400,000.

News of the A.S.M.E. Woman's Auxiliary

THE Woman's Auxiliary met at the Engineering Societies Building, Thursday afternoon, January 12, to install the officers elected for 1939. Mrs. George W. Farny, the president succeeded herself. Inducted into office were Mrs. John H. R. Arms, first vice-president; Mrs. E. C. Stahl, second vice-president; Mrs. R. B. Purdy, third vice-president; Mrs. Coleman Sellers, 3rd, fourth vice-president; Mrs. H. A. Schwartz, fifth vice-president; Mrs. Charles Gus, recording secretary; Mrs. P. E. Frank, corresponding secretary, and Mrs. A. H. Morgan, treasurer, were also inducted into office.

The chairmen of the committees for the coming year are: Courtesy, Mrs. C. G. Humphreys; Custodian, Miss Burtie Haar; Education, Mrs. R. V. Wright; Hospitality, Mrs. C. H. Young acting for Mrs. J. T. McQueeny; Membership, Mrs. R. B. Purdy; Program, Mrs. C. B. LePage; Publicity, Miss Burtie Haar; Sponsors of Local Sections, Mrs. J. H. R. Arms; Ways and Means, Mrs. F. M. Gibson; Sponsor for Cleveland Section, Mrs. V. M. Frost; Sponsor for Philadelphia Section, Mrs. G. L. Knight; Sponsor for Baltimore Section, Mrs. A. Kingsbury.

At this meeting was given the first showing of the film of the Annual Meeting, which was greatly enjoyed.

After the business meeting, Miss Anna G. Price, member of the National Association of Women Sculptors and Painters and also of the Pen and Brush Club gave an illustrated talk on "How an Artist Sees the Italian Hill Towns and Their Art." Miss Price made her subject so vitally interesting that the discussion was continued while tea was served.

The January, 1939, news letter of the Auxiliary sent a greeting and news from our President, Mrs. Farny, to all the membership. It is hoped through this means that members may be kept more in touch with each other and may thus present suggestions throughout the year as well as at the time of the Annual Meeting.

On February 9 at the Engineering Womans Club, the Auxiliary enjoyed luncheon before the regular monthly meeting. Real satisfaction of accomplishment was the result of a letter read by the chairman of the Education Committee, Mrs. R. V. Wright, from one of the recipients of a loan from the Auxiliary. He is now chief engineer of his firm and attributes his success to the aid given him, when needed, by the Auxiliary's Student Loan Fund.

The speaker of the afternoon was Dr. Chih Meng, director of the Chinese Institute. His subject was "Some Economic Aspects of the Chinese Situation," and he presented an unprejudiced view of the present situation in China. Since 1929 engineering students from China have been coming to American colleges to study and now only half as many as formerly are able to take advantage of such opportunities. The March meeting will be held March 9 at the Electrical Testing Laboratories as the guest of Mrs. F. M. Farmer.

BURTIE HAAR,
Chairman, Publicity Committee

American Engineering Council

Presents

The News From Washington and Elsewhere

National Legislation Affecting Engineers

AS IS customary in the opening of a new Congress in Washington, D. C., several hundred bills have already been introduced, many of which will probably not get beyond committees of the two legislative houses. Out of the many bills which have been introduced, the following touch upon problems in which American Engineering Council may be expected to be asked for factual information.

National Resources Board

Senate bill 19 by Senator Hayden proposes the establishment of a National Resources Board, which will be composed of seven members, four to be appointed by the President with advice and consent of the Senate; compensation, $10,000 per year; term, four years. Other three members to be employees of the Departments of War, Agriculture, and Interior, respectively, designated by the secretary of each department.

Board will be authorized (*a*) to conduct investigations, examinations, and studies; to analyze, assemble, coordinate, and from time to time, review and revise basic information and materials appropriate to planning for conservation and development of the natural resouces of the United States; and on basis thereof initiate and propose, in advisory capacity only, plans and planning policies; (*b*) in furtherance of these ends, to consult with any federal, state, or local governmental agency, or with any public or private planning or research organization; and (*c*) to prepare reports and recommendations upon matters within its jurisdiction upon request of either the President or the Congress.

It also authorizes formation of regional planning boards, subject to supervision and control of the National Board, each to consist of seven members, three to be selected by the Board from the Departments of War, Interior, and Agriculture, and four to be residents of the area served by the regional board.

It also authorizes the transfer to the Board of records, property obligations, and unexpended monies made available to the National Resources Committee. Bill referred to Committee on Public Lands and Surveys.

Division of Water Pollution

H.R. 2890 was introduced by Representative Bland. It is cited as the Water Pollution Act, and establishes a Division of Water Pollution Control in the U. S. Public Health Service, with a commissioned officer from the Service as director. The Division is to prepare, in cooperation with the Chief of Engineers of the War Department and state agencies, a comprehensive plan for prevention of pollution of navigable waters and tributaries, to encourage state pollution-control activities, uniform laws, and interstate compacts. It authorizes an annual appropriation of $300,000 for maintenance of the Division, and $700,000 to be allotted to states for necessary investigations. It provides further for loans to state or persons for construction of sewage-treatment works. Referred to the Committee on Rivers and Harbors.

Government Reorganization

The House of Representatives has taken important action in forwarding reorganization of the Federal agencies by adopting the Cochran Resolution (H.R. 60), which authorizes the Select Committee of Government Organization to continue its work, grants the committee the same power, authority, and jurisdiction as that conferred upon it by the 75th Congress and provides further, "that any bills or resolutions reported by the committee shall have a privileged status and it shall be in order to consider any such bills or resolutions so reported without the intervention of any point of order."

Registration of Engineers

S. 1128 by Senator King proposes to regulate the practice of professional engineering in the District of Columbia by creating a board for the licensure of professional engineers. The bill creates a board of five members, at least one each in civil, electrical, mechanical, and structural engineering. It would make it unlawful to practice professional engineering in the District of Columbia, except in branches thereof for which a specific license is obtained. Referred to Committee on District of Columbia.

Research

H.R. 1663 by Representative Lanham proposes to aid engineering and industrial research in connection with college and schools of engineering in the several state and territorial universities and colleges. The bill would establish in each state and territory an engineering research bureau or station, to be under the direction of one or more colleges or schools of engineering of graduate grade. Secretary of Commerce will administer the provisions of the act, and also indicate from time to time such lines of inquiry as to him seem most important. Referred to Committee on Interstate and Foreign Commerce.

Social Security

Numerous bills recommending amendment and expansion of the Social Security Act have been introduced in the current Congress and the majority of them referred to the Committee on Ways and Means of the House of Representatives, the same committee which considered the original Act. It is probable that some legislation will be enacted, but it is yet too early to be sure what will happen, due in part to the fact that the change in the composition of both the House and Senate have made many changes in committee personnel.

The Ways and Means Committee has for its guidance a message from the President, the report of the Social Security Board, and the report of the Social Security Advisory Council, composed of representatives of employees, employers, and the public, all of which contain definite recommendations for expansion of the Act, as well as improvements in its administration. There is evidence to believe that the Act will be extended to include employees of nonprofit, religious, charitable, and educational organizations. No recommendations have been made to provide for the self-employed individual.

Gano Dunn Appointed to Civil Service Committee

A COMMITTEE to study, among other things, the relation of civil service to legal and technical positions has been appointed by President Roosevelt. Engineers are represented on the committee by Gano Dunn, member A.S.M.E., and president of the J. G. White Engineering Company. The other members of the committee include Justice Stanley Reed of the U. S. Supreme Court, chairman; Justice Felix Frankfurter; Attorney-General Murphy; William H. McReynolds, administrative assistant to Secretary Morgenthau; Leonard White, a former civil-service commissioner and now professor of political science at the University of Chicago; and Gen. Robert Wood, chairman of the board of Sears, Roebuck and Company.

The statement issued at the White House explains that "the committee selected by the President will study the many diverse problems presented in the recruitment and promotion of the professional, administrative, and other technical personnel for the various government departments and agencies. The President believes that such a study will result in an informed and wise extension of the merit system and the application of higher standards in the selection and promotion of such government personnel."

F. E. Raymond Accepts Directorship of Patent Inquiry

FAIRFIELD E. RAYMOND, member A.S.M.E., and associate professor of industrial research of M.I.T., has accepted the directorship of the patent inquiry to be carried out under the auspices of the Patent Committee of the American Engineering Council with funds provided by the National Industrial Conference Board. Professor Raymond's headquarters were opened on February 15 in the office of the Council in Washington, D. C.

1939 Officers of A.S.C.E. Installed at Recent Annual Meeting

D. H. SAWYER

OFFICERS of the American Society of Civil Engineers for 1939, who were installed at the annual meeting of the Society in New York, Jan. 18–21, 1939, are Donald H. Sawyer, special assistant to the Director of Procurement and Chief of the Section of Space Control in the U. S. Treasury Department, as president; C. M. Reppert and J. L. Ferebee, as vice-presidents; and H. W. Hudson, H. M. Lewis, S. W. Sawin, C. T. Leeds, R. B. Brooks, and E. S. Bres, as directors.

Compressed-Air Safety Code Now Available From A.S.M.E.

COMPLETION and approval of the first safety code for compressed-air machinery and equipment has just been announced by the American Standards Association. This code is designed to cut down the number of accidents resulting from the wide use of compressed air today in garages, for rock drilling, for mining machinery, for cleaning, chipping, hoisting, and numerous other industrial applications. Under the administrative leadership of The American Society of Mechanical Engineers and the American Society of Safety Engineers, 19 national organizations, and 2 departments of the Federal government participated in its development.

The code, just published by the A.S.M.E. in a sixteen-page booklet, may be obtained from the A.S.M.E. at a cost of 30 cents.

Mathematicians to Meet in Cambridge, Mass., in 1940

ON INVITATION of the American Mathematical Society, the International Congress of Mathematicians is to meet in Cambridge, Mass., Sept. 4–12, 1940. Further information may be obtained from Prof. R. D. G. Richardson, secretary of the Congress, Brown University, Providence, R. I.

Second Anthracite Conference, Lehigh University, Apr. 28–29

THE SECOND Annual Anthracite Conference will be held on Apr. 28–29, at Packard Memorial Hall, Lehigh University, Bethlehem, Pa. Further information may be obtained from Prof. Howard Eckfeldt, chairman of the Conference.

A.S.M.E. Delegates to Duke Celebration and Philadelphia Meeting

THE A.S.M.E. will be represented at the Centennial Celebration of Duke University at Durham, N. C., Apr. 21–23, 1939, by Prof. George B. Pegram, graduate dean of the faculties of political science, Columbia University.

At the 43rd annual meeting of the American Academy of Political and Social Sciences in Philadelphia, March 31 and Apr. 1, the Society's delegates will be Lester C. Bosler, chairman, A.S.M.E. Fuels Division; S. Logan Kerr, manager, chemical engineering division, United Engineers and Constructors, Inc.; and Chas. C. Jones, chairman, A.S.M.E. Philadelphia Section.

F. M. Farmer Nominated for A.I.E.E. President

F. M. FARMER

F. M. FARMER, member A.S.M.E., and vice-president and chief engineer, Electrical Testing Laboratories, has just been nominated for the office of president of the American Institute of Electrical Engineers for the year beginning Aug. 1, 1939. Other candidates nominated at the same time were C. T. Sinclair, E. E. George, A. L. Turner, H. W. Hitchcock, and J. M. Thomson for vice-presidents; Mark Eldredge, R. E. Hellmund, and Frank J. Meyer for directors; and W. I. Slichter, member A.S.M.E., for national treasurer.

A.S.M.E. Members Offered Pamphlets on Combustion

A COMMUNICATION received at A.S.M.E. headquarters from Prof. A. Metral, delegue general, Société Francaise des Mecaniciens (French Society of Mechanical Engineers), 29, Rue de Berri, Paris, France, states that the 35 papers presented at a recent symposium on "Combustion at Constant Volume" are now available in two paper covered volumes which may be purchased by any A.S.M.E. member for $2, which includes postage. Printed in French, the papers are grouped under physics and chemistry of combustion at constant volume and the thermodynamics and applications in internal-combustion engines.

Leipzig Trade Fair, March 5–13, 1939

THE SPRING SESSION of the Leipzig Trade Fair will be held Mar. 5–13, 1939. It will comprise about 10,000 exhibits from 34 producing countries, including the United States. This fair will be the 1981 session of the historic exchange which has been in existence for more than 700 years.

A.S.T.M. Regional Meeting Columbus, Ohio, March 6–10

THE 1939 Regional Meeting of the American Society of Testing Materials will be held at the Deshler-Wallick Hotel in Columbus, Ohio, in conjunction with committee meetings, March 6–10. Among the technical features are symposiums on thermal insulating materials and lime. It is expected that some 150 meetings of standing committees and their subgroups, on many of which the A.S.M.E. is represented, will be held.

Building Materials Research at Mellon Institute

MELLON INSTITUTE, Pittsburgh, has announced the establishment of an industrial fellowship in that institution by the United States Gypsum Co., of Chicago, Ill. This Fellowship will conduct fundamental research on various products manufactured by the donor company, with the objective of developing new processes and technics which will have broad application in the field of building materials. This investigational work will augment the regular research activities carried on by the donor. Dr. H. E. Simpson has been appointed to the Fellowship.

Timber-Bridge Design Contest

A TIMBER-BRIDGE design contest has been announced by the National Lumber Manufacturers Association, 1337 Connecticut Avenue, Washington, D. C., which is open to students of architecture and engineering as well as graduates. Grand prize will be $500 in cash and, in addition, there will be six other prizes in this division from $200 down to $50, and 17 student awards totaling $300. The rules require that the design submitted shall be of a highway bridge constructed of timber and employing the timber-connector method of construction.

Marine Engineers Elect Smith for President

AT THE annual meeting of The Society of Naval Architects and Marine Engineers in December, H. Gerrish Smith was elected president of the Society for a two-year term starting Jan. 1, 1939. At this same meeting H. King was reelected secretary-treasurer.

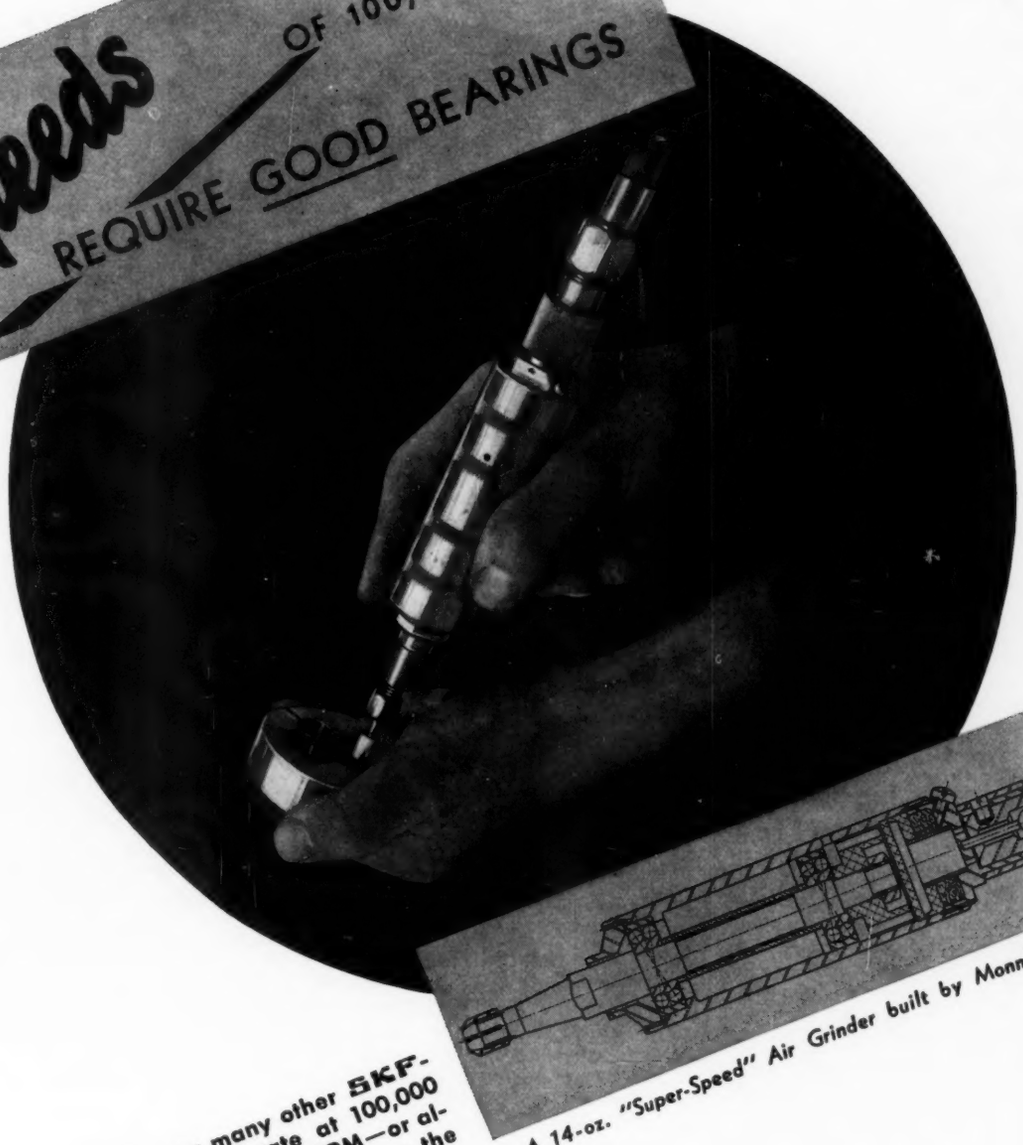
Local Sections

Coming Meetings

Anthracite-Lehigh Valley: March 24. Y.M.C.A., Pottsville, Pa., at 8:00 p.m. Showing of movie "Buried Sunshine," a picture of anthracite coal presented by the Philadelphia and Reading Coal and Iron Co. Subject: "Polarized Light," by Paul M. Kendig, professor of

(*A.S.M.E. News continued on page 266*)

Speeds OF 100,000 RPM REQUIRE GOOD BEARINGS



• A 14-oz. "Super-Speed" Air Grinder built by Monnier Bros., Inc.

WE DON'T KNOW how many other SKF-equipped machines operate at 100,000 RPM, but we do know that 100,000 RPM—or almost 2,000 *revolutions per second*—requires the utmost in bearings.

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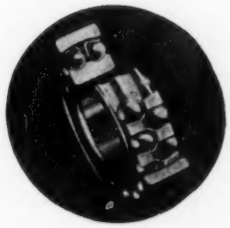
BALL BEARINGS



physics and mathematics, The Pennsylvania State College.

Baltimore: March 2. Johns Hopkins University, Baltimore, Md., at 8:15 p.m. Subject: "Diesel Engines," by a staff member from the General Motors Corporation.

Birmingham: March 1. Tutwiler Hotel at 7:45 p.m. Subject: "Building a Profession," by C. E. Davies, secretary A.S.M.E.

Charlotte: March 13. Luncheon meeting at 1:00 p.m. at the Charlotte Hotel, Charlotte, N. C. Subject: "Building a Profession," by C. E. Davies, secretary A.S.M.E.

Chicago: March 10. One-day statistical meeting to be held at the Electric Lighting Institute Theatre, 20 North Wacker Drive, Chicago. The A.S.M.E. Chicago Section, is cooperating with the American Institute of Mining and Metallurgical Engineers, The American Institute of Electrical Engineers, and the American Statistical Association. Speakers and topics for this meeting will be found in a news item on page 254 of this issue.

March 21. Subject: "Flow of Gases in Exhaust Lines From Internal-Combustion Engines and Its Relation to Engine Performance and Noise," by R. L. Ledbetter.

Three other meetings, sponsored by the Junior Group, the Management Section, and the Transportation Section, are scheduled for March.

Cleveland: March 6. There will be a dinner at 6:30 p.m. at the Case Club with motion pictures of the Annual Meeting to feature the program, followed by a regular meeting. Subject: "High-Speed Traffic Arteries for Cleveland," by A. S. Porter, chief deputy county engineer, Cuyahoga County Engineering Department.

Erie: March 21. Pennsylvania Telephone Corporation Auditorium at 8:00 p.m. Subject: "Present and Future Sources of Power," by C. C. Furnas, associate professor, department of chemical engineering, Yale University.

Metropolitan: March 9. Engineering Societies Building, Room 501, 29 West 39th St., New York, N. Y., at 7:30 p.m. Subject: "Grand Coulee Dam," by R. B. Renner, Jeffrey Mfg. Co., together with motion pictures explaining construction and material-handling methods. This meeting will be under the auspices of the transportation and hydraulics divisions of the Section.

Minnesota: March 27. Minnesota Union, University of Minnesota at 6:30 p.m. Subject: "Mechanics of Vibration," by James Jay Rayn, professor of machine design, University of Minnesota.

Philadelphia: March 28. Engineers Club Philadelphia, Pa., at 7:45 p.m. Subject: "Welding in Power Plants," by N. L. Mochel of Westinghouse Electric & Manufacturing Co., Philadelphia Works.

Providence: March 7. Providence Engineering Society Building at 8:00 p.m. Subject: "The Problem of Arming the Individual Soldier," by Melvin M. Johnson, Jr., president of Johnson Automatic Trust.

Washington, D. C.: March 9. Potomac Electric Power Co. Auditorium at 8:00 p.m. Subject: "Modern Steam Generators," by A. G. Christie, president A.S.M.E., and professor of mechanical engineering at Johns Hopkins University, Baltimore, Md.

Waterbury: March 15. The Elton Hotel at 7:00 p.m. Subject: "Some Methods and Requirements of Optical Measurement and Inspection in the Shop," by F. J. Loomis, industrial sales engineer, Bausch & Lomb Optical Co.

Worcester: March 21. Dinner at 6:45 p.m., meeting at 7:45 p.m., at Sanford Riley Hall, Worcester Polytechnic Institute. Several student members will present papers which have been chosen from those presented at student meetings.

Men and Positions Available

Engineering Societies Employment Service

MEN AVAILABLE[1]

TECHNICAL GRADUATE, B.S., U. S. Naval Academy; M.S. in M.E. Experience includes sales, teaching, design, construction, maintenance, operation Diesel-electric plant, air conditioning and refrigeration plants, management and personnel work. Me-240.

RECENT GRADUATE in management engineering, 25, single. Desires position in industrial engineering work; 3 years precollege experience making and selling wood products in home workshop. Me-241.

MECHANICAL ENGINEERING GRADUATE, age 27. Now employed. Design and drafting experience with railroad-supply firm. Also stenographic training and experience. Desires position leading to executive or supervisory capacity. Me-242-9398-Chicago.

MECHANICAL ENGINEER, graduate Stevens Institute, licensed professional engineer, N. Y. State; 25 years' manufacturing experience, metals and machinery. Can fit efficiently in most any department under supervision or supervising. Me-243.

MECHANICAL ENGINEER, 40. Seven years' power-plant operation, testing, and design experience central-station power plants; 12 years' editorial experience technical steam and Diesel power-plant magazines. New York professional license. Me-244.

MECHANICAL ENGINEER, 38. New York professional license. Design and construction power and process equipment for industrials; 13 years with consulting engineer; last 5 with process industry. Broad experience and accomplishments. Me-245.

MECHANICAL ENGINEER, 29. Six and one-half years operating, testing, and experimental work steam-power station, medium and high-pressure equipment; 2 years' sales engineering; desires permanent position steam-power engineering; location immaterial. Me-246.

FACTORY MANAGER with industrial-engineering background. Experienced in budgetary controls, labor controls, and standard costs; 8 years' industrial-engineering experience; 3 years' experience in factory management. At present employed but desires to make change. Me-247.

TEXTILE EXECUTIVE ENGINEER, registered, age 40. Twenty years' varied plant-layout design modern maintenance methods; wishes to make change; location North. Me-248.

MECHANICAL ENGINEER, 39. Fourteen years' experience design, construction, operation various steam-power plants and industrial-process steam and other equipment. Desires position either as power superintendent or plant engineer. Location immaterial. Me-249.

MECHANICAL ENGINEER, graduate, age 25. Knowledge of refrigeration, air conditioning, steam-turbine design, and relay controls. Experience in planning and scheduling production. Proved ability to organize and direct factory personnel. Me-250.

GRADUATE MECHANICAL ENGINEER, June, 1938, age 23, now employed. Experience: Drafting and design of control equipment. Desires industrial connection in New York Metropolitan area. Me-251.

ASSISTANT PROFESSOR of mechanical or industrial engineering. Graduate mechanical engineer with master's degree; 6 years' experience in shop and costs; 3 years' mechanical college teaching. Married. Me-252.

GRADUATE MECHANICAL ENGINEER, age 24. Experienced in designing, drafting, and testing of rotary gas burners, steam turbines, air filters, and blowers. Systematizing and bills of material. Me-253.

MECHANICAL ENGINEER, 26, single, recent graduate, University of Utah. Desires position with engineering work. Well grounded in engineering fundamentals. Willing to go anywhere, start at bottom. Available immediately. Me-254-391-D-6-San Francisco.

POSITIONS AVAILABLE

CHIEF ENGINEER, 40–45, graduate of university of recognized standing, capable of supervising high-speed production on small metal parts. Should be thoroughly acquainted with machine shop and operation of high-speed automatic machinery. Executive ability and experience are essential. Salary, $5000 a year. Location, East. Y-3313.

DESIGNER with experience in design of Diesel engines. Must have about five years' experience in designing, or in general drafting work, and should have been graduated from engineering school of recognized standing. Will involve changes to existing designs, revamping, detailing, checking drawings, and general Diesel work. Location, Pennsylvania. Y-3756.

GRADUATE MECHANICAL ENGINEERS with at least ten years' designing experience. Must be capable of making layouts of designs of Diesel engines, and also of checking drawings. Location, New York State. Y-3773.

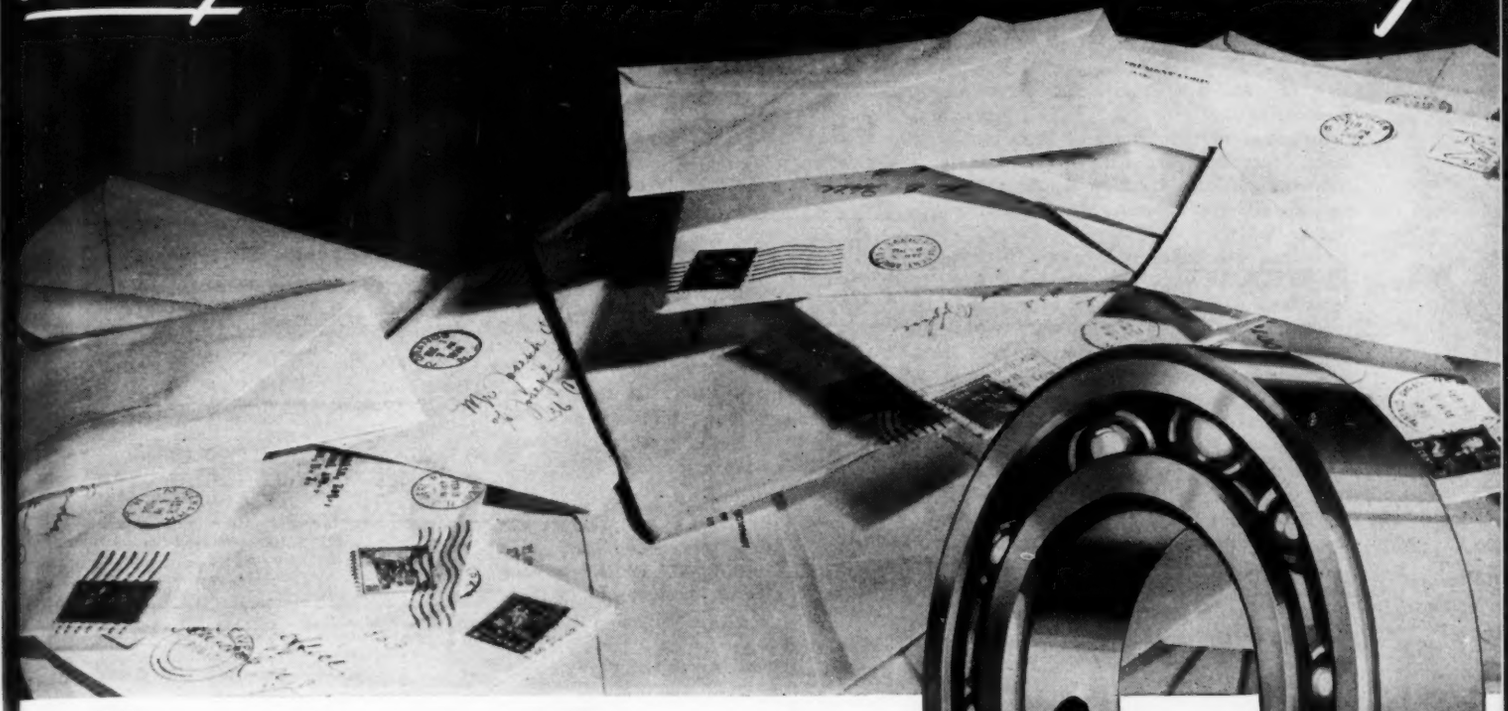
GRADUATE MECHANICAL ENGINEER, 35–40, to act as assistant to chief engineer. Must have experience in metal-working plant. Process planning experience essential. Company manufactures blowpipes, regulators, etc. Location, New York, N. Y. Y-3784.

DESIGNER, Swedish, with experience in de-

(A.S.M.E. News continued on page 268)

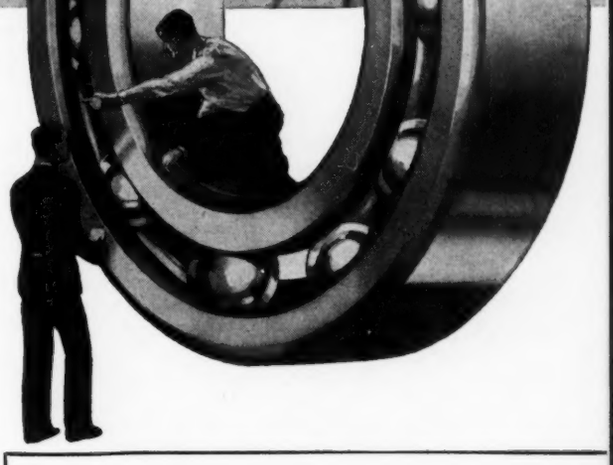
[1] All men listed hold some form of A.S.M.E. membership.

Every letter tells the Same Story



Nothing Equals

BALL BEARING LUBRIPLATE!



Talk about praise! . . . in our files are unsolicited letters by the hundreds—letters that tell in no uncertain terms what Ball Bearing Lubriplate has done, and what it's doing every day! They tell of new *savings* . . . new *efficiency* . . . new *performance*. They tell of problems solved that had baffled other lubricants completely.

"CUTS BEARING WEAR!"

"We used to buy new bearings about every month. Since we adopted Lubriplate over five years ago, we have replaced only one bearing race." Pleased? Says the manager, "If Lubriplate cost $1.50 a pound, we could still afford to use it!"

"STOPS OVERHEATING"

"After replacing ordinary lubricant with Ball Bearing Lubriplate, the temperature of ball bearings running at 1800 rpm dropped from 170°F. to a range of 130°-140°F." Ball Bearing Lubriplate is suitable for bearings operating at speeds up to 5000 rpm, at temperatures from Zero to 300° F.

"REQUIRES LESS ATTENTION"

A leading leather manufacturer writes, ". . . the old grease had to be looked at and replenished three times each day. With Lubriplate, bearings are checked every 10 or 12 days, and need no attention between checking periods."

SEND FOR FREE SAMPLE

There's only one way to learn what Ball Bearing Lubriplate will do for you—and that's to try it! Try it on bearings that run hot . . . bearings that require frequent replacement . . . bearings that won't retain lubricant. In other words, try it on the toughest, most troublesome bearing problems in your plant! And you *can* try it—FREE! This generous FREE can enables you to try Ball Bearing Lubriplate in your *own* plant, on *own* bearings under your *own* operating conditions. Send for it—today!

QUICK FACTS:

1. *Lubriplate produces a wear-resisting bearing surface.*
2. *Lubriplate resists rust, corrosion and pitting.*
3. *Lubriplate reduces friction, thus lowering maintenance costs and power costs.*
4. *Lubriplate is white and clean.*
5. *Lubriplate outlasts ordinary lubricants many times.*
6. *Lubriplate is economical—a little goes a long ways.*
7. *Lubriplate is available in fluid and grease types for every need.*

Fiske Bros. Refining Co., 129 Lockwood St., Newark, N. J.

Yes! I want to prove to my own satisfaction that Ball Bearing Lubriplate will save time, attention and money in lubricating bearings. Send me a generous trial can, without obligation.

Name.....

Company.....

Address.....

City.....State.....

LUBRIPLATE DIVISION OF

FISKE BROTHERS REFINING CO.

sign of ventilating equipment. Location, Sweden. Y-3790.

ENGINEER to take charge of operation of mill. Must be familiar with operation of air compressors, drills, crushers, conveyers, elevators, vibrating screens, etc. Location, South. Y-3793.

GRADUATE MECHANICAL ENGINEER, not over 35, for editorial work for trade publication. Must have few years' practical experience in mechanical department of steam railway or in dealing with some phase of motive power or rolling-stock design or operation. Must also have good command of English and ability to write clearly without too great effort. Location, New York, N. Y. Y-3802.

DESIGNER with experience in heavy mechanically operated presses. Background of experience in heavy hydraulic presses also desirable. Location, Pennsylvania. Y-3819.

ASSISTANT SUPERINTENDENT OR PRODUCTION MANAGER for electric-motor factory. Experience as assistant superintendent, production manager, or superintendent of electric-motor plant essential. Y-3824.

MECHANICAL ENGINEER, 35–43, with thorough knowledge of heating, plumbing, electric wiring, and principles of lighting. Must also have some air-conditioning experience. Chain-store experience valuable. Must have good personality, tact, diplomacy. Considerable traveling. Salary, $250–$275 a month plus expenses. Location, Middle West. Y-3842.

DESIGNER with several years' experience in design of welded structures. Design experience in Diesel-engine structures desirable, but man with all-round experience in design of welded-steel structures for heavy machinery preferred. Must be capable of making layouts, including stress calculations for them. Location, New York State. Y-3847.

PLANT ENGINEER, 40–45, graduate of university of recognized standing, to act as head of large plant department. Work will involve supervision of maintenance of tools and equipment, heat-treating, automatic machinery, etc. Must have experience in construction and maintenance, and be capable of supervising large force of men. Salary, $5000 a year. Location, East. Y-3852.

RESEARCH GRADUATE ASSISTANT for work in mechanical engineering. Essential training in mechanical engineering is desirable, but in lieu thereof, thorough preparation in physics, chemistry, and mathematics is required. Preference will be given to applicant with previous experience in research, graduate study, or engineering employment. Appointment is for period of twelve months, beginning September 1, 1939, and carries stipend $1000. Apply by letter giving full details of training and experience, and including recent photograph. Location, South. Y-3863.

CHIEF TOOL DESIGNER. Supervisory experience in design of forging and press dies essential. Salary, $2600 a year. Location, New England. Y-3871.

GRADUATE ENGINEER with 10–15 years' experience general plant maintenance, industrial construction, equipment installation. As assistant to a plant engineer. Prefer experience in processing or chemical industry. Will be responsible for directing the work of others; and must have initiative. Salary, $4000–$5000 a year. Location, New York, N. Y. Y-3878.

MECHANICAL ENGINEER, 25–40, with experience in design and fabrication of pressure vessels. Must have good personality, and be able to write copy and editorials from contacts with the company's customers. Will eventually become specialist in certain line of fabrication. Location, Pennsylvania. Y-3907.

Candidates for Membership and Transfer in the A.S.M.E.

THE application of each of the candidates listed below is to be voted on after March 25, 1939, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references.

Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

Re = Reelection; Rt = Reinstatement; Rt & T = Reinstatement and transfer to Member

NEW APPLICATIONS

For Member, Associate or Junior

AIKINS, JOHN R., Pittsburgh, Pa.
BALLAUER, ALB C., Ferguson, Mo.
BROCK, C. A., Chicago, Ill.
BRYANT, STUART G., Belleville, N. J.
COGAN, M. H. R., Curacao, D. W. I.
COSENTINO, MICHAEL, Woodhaven, L. I., N. Y.
DAUBER, JOSEPH, Chicago, Ill.
DAVIS, E. L., Duncan, S. C.
DECK, ALBERT E., Duncan, S. C.
GORMAN, JOS. HARRY, Jersey City, N. J.
GREENSLADE, G. R., Pittsburgh, Pa.
HODGSON, ROBERT A., Coffeyville, Kan.
HUGHINS, GORDON R., Alton, Ill.
JANGIDA, J. B., Dalmia, Dadri, India
KAYES, W. J., Fergus, Ont., Canada
KOESTER, CHAS. T., SR., Brooklyn, N. Y.
LEACH, C. RANDOLPH, JR., New York, N. Y. (Re)
LEITCH, KELVIN D., Toronto, Ont., Can.
MATHESON, E. E., Oakland, Calif. (Rt & T)
MIYAUCHI, KEN'ICHI, Ibaraki-Ken, Japan
MORGAN, H. WURTH, San Gabriel, Calif.
OATES, LAURENCE D., Sacramento, Calif.
OTT, VERNER L., New York, N. Y.
PATERNOSTER, JOSEPH A., West New Brighton, S. I.
PERRIN, ARTHUR M., Brooklyn, N. Y.
PFEFFERLE, GEO., Bradford, Pa. (Rt)
PFEIFFER, DAVID C., Dallas, Tex. (Rt & T)
RAMASWAMY, S., South Malabar, India
STEWART, JAMES P., Jeannette, Pa.
STILES, E. M., Trail, B. C. (Re)
TURNER, ROBERT E., Conowingo, Md.
URSPRUNG, HERMAN, Entre Rios, Argentina
VANCE, CARL B., Kansas City, Mo. (Re)
WHITSON, LEE S., Minneapolis, Minn. (Re)

CHANGE OF GRADING

Transfer to Fellow

ADAMS, COMFORT A., Philadelphia, Pa.
STAHL, NICHOLAS, Allentown, Pa.

Transfers to Member

CRAIN, H. L., Kansas City, Mo.
DAVIDSON, RUPERT R., Maryville, Tenn.
HARTWELL, HIRAM BRITTON, Waltham, Mass.
HUBBARD, CLYDE W., Worcester, Mass.
KANE, ALVIN B., Cincinnati, Ohio
KRAMER, HAROLD K., Great Neck, L. I., N. Y.
LARSON, REINHOLD F., Urbana, Ill.
SCHMIDT, KNUTE M., Elizabethton, Tenn.

Necrology

THE deaths of the following members have recently been reported to the office of the Society:

ADLER, ALPHONSE A., January 13, 1939
CARPENTER, CHARLES I., December 24, 1938
DOWNE, HENRY S., December 8, 1938
HOUGH, DAVID L., October 12, 1938
IRONS, ROBERT H., January 5, 1939
KAIER, RICHARD, January 10, 1939
ROWLAND, THOMAS F., JR., January 12, 1939
SANDERS, NEWELL, January 26, 1939
SKAGEN, SVERRE, July 6, 1938

A.S.M.E. Transactions for February, 1939

THE February, 1939, issue of the Transactions of the A.S.M.E. contains the following papers:

Trends in Fuel-Burning Equipment and Furnace Design as Shown by Recent Eastern-Seaboard Applications, by R. D. Booth

Operating Methods and Problems of Combined Hydro- and Steam-Electric System, by H. L. Harrington and E. B. Strowger

The Kaplan Turbines at Bonneville, P. L. Heslop and G. A. Jessop

Theory of Resonance in Pressure Conduits, by Charles Jaeger

Typical Analysis of Water Hammer in a Pumping Plant of the Colorado River Aqueduct, by R. M. Peabody

Condenser-Tube Life as Affected by Design and Mechanical Features of Operation, by A. J. German

Condenser Performance With Reduced Cooling Surface, by J. H. Harlow and R. A. Bowman

Further Experiments in the Planing of Hardwoods, by E. M. Davis

Obsolescence in Woodworking Machinery, by P. T. Norton, Jr.

The Mechanical Characteristics of Rubber, by F. L. Haushalter

DISCUSSION

On previously published papers by H. L. Tiger; S. J. Needs; L. M. Tichvinsky; John Van Brunt; F. L. Everett and Arthur McCutchan